COMMONWEALTH OF AUSTRALIA.

DEPARTMENT OF NATIONAL DEVELOPMENT.

BUREAU OF MINERAL RESOURCES GEOLOGY AND GEOPHYSICS.

RECORDS.

1961/132

REPORT OF THE MINOR INVESTIGATIONS CARRIED OUT IN THE PETROGRAPHIC AND MINERAGRAPHIC LABORATORY GEOLOGICAL BRANCH, JANUARY - JUNE 1960

Compiled by

G.J.G. Greaves

REPORT OF THE MINOR INVESTIGATIONS CARRIED OUT IN THE PETROGRAPHIC AND MINERAGRAPHIC LABORATORY GEOLOGICAL BRANCH, JANUARY - JUNE 1960.

Compiled by

G.J.G. Greaves.

Records 1961/132

INTRODUCTION

This record consists of a collection of minor reports completed by the petrographic and mineragraphic sections of the Geological Laboratory during the half-yearly period January to June 1960. The reports have been placed in chronological order, and each one has its date of completion and the relevant file number above its heading.

The officers responsible for these reports are - W.B. Dallwitz, W.M.B. Roberts, K.R. Walker, W.R. Morgan and C.M. Gregory.

Report No.1 was omitted from the record for 1959 and is recorded here.

CONTENTS.

CONTENTS (Contd)

84NT/4A
January, 1959.

Report No. 1

ANALYSES OF RADIOACTIVE SAMPLES FROM RUM JUNGLE, NORTHERN TERRITORY

by

W.M.B. Roberts

Following are the results of analyses for uranium and other selected elements on a group of radioactive samples from Whites' Mine, Rum Jungle, Northern Territory.

The samples were analysed so that a comparison could be carried out between the X-ray spectrographic and the A.C. Palarographic methods of analysis.

Table I lists the duplicate veins on the samples for $\%U_2O_8$, and Table II lists the same quantitative analyses for the selected elements.

Statistical analysis indicates that the percentage given in Table I will be $\pm$ 0.15%.

TABLE I

	Run I	Run II
	%U	%U
1242	4.70	4.85
1231	4.65	4.65
B7432	5.05	5.10
3009	0.71	0.705
1126	6.10	6.25
2999	2.28	2.27
1230	7.40	7.60
1661	2.33	2.45
1118	3.75	3.90
2384	1.28	1.33

TABLE 2

Sample No.	Fe%	As%	Pb%	Ni%	Co%	Cu%	Zn%
1242	About 5	2	2	Tr.	Tr.	1	2
1231	About 10	1	1	Tr.			2
B7432	5-10	2	2	1	1	0.5	2
3009	5-10			Tr.	Tr.		Tr.
1126	5-10		2	Tr.	Tr.	2	2
2999	5-10		0.5	1	0.5	1	1
1230	About 10	2	2	Tr.	Tr.	1	1
1661	About 5	2	1-2	Tr.	Tr.	0.5	1
1118	5-10		<1	Tr.	Tr.	Tr.	2
2384	5-10		0.5			1	1

66PNG/1
15th January, 1960.

Report No. 2

MINERALOGICAL EXAMINATION OF A MAGNETITE SAND, BOUGAINVILLE ISLAND, NEW GUINEA

by

W.R. Morgan

Herewith are the results obtained from a magnetic and heavy liquid separation, and a grain count analysis, of a sample of magnetite sand, from Bougainville, T.P.N.G., submitted by J.E. Thompson.

Magnetite	87.0
Plagioclase	3.1
Haematite	2.5
Clinopyroxene	2.4
Hornblende	2.3
Carbonate	2.0
Orthopyroxene	0.7
	100.0

Traces of ilmenite, leucoxene, zircon and quartz are present. A. McClure found by chemical analysis that the magnetite contains 8.18% TiO_2.

106N/1
18th January, 1960.

Report No. 3

PETROLOGICAL DESCRIPTION OF A SPECIMEN FROM THE LAKE CULLIVEL BORE, NEAR URANA, N.S.W.

by

W.B. Dallwitz

Following is a description from a depth of 1145 - 1149 feet in the Lake Cullivel Bore, near Urana, New South Wales. This bore is being put down to test for petroleum. The problem is to find the degree of metamorphism of the rock with a view to determining whether drilling should stop.

A thin section (No. 5166) of the fragments shows that they consist of sericitic quartz siltstone and slate. The average grainsize of the quartz grains in the siltstone is 0.01 mm. in diameter. Quartz is the dominant mineral; minor constituents are sericite chlorite, and leucoxene, and accessories are biotite, black iron-ore, and limonite.

The slate fragments consist predominantly of sericite; some contain a minor amount of quartz, others none whatever. Fine specks of leucoxene are plentiful; accessory minerals black iron-ore and limonite.

The sericite flakes in both the siltstone and the slate have strong parallel alignment.

There is no conclusive evidence that these rocks have undergone thermal metamorphism.

Their mineralogy, grainsize, and texture are consistent with their being folded or tilted, and compressed to the stage where a moderately strong regional cleavage has been impressed on them. Alternatively the cleavage may equally well be due to load-metamorphism, provided the thickness of sediment had been sufficient to bring this about.

It is possible that some very slight thermal metamorphism has taken place in the rocks, but unless evidence supporting such a suggestion could be obtained by examining similar rocks higher and lower in the drill-hole, it would not be warranted to give any serious consideration to that possibility.

106G/13/43
20th January, 1960.

Report No. 4

PETROLOGICAL EXAMINATION OF A SAMPLE FROM A.F.O. COOROORAH NO. 1 BORE

by

W.B. Dallwitz

Following is a description of part of Core 15 from A.F.O. Cooroorah No. 1 bore, at 3040 - 3045 feet.

In handspecimen the rock is dark grey, and consists of an apparently fine-grained matrix containing subhedral grains of feldspar measuring up to 2 mm. in length and grey to brown rock fragments measuring up to about 3/4 cm. across. The long axes of many of the feldspar grains are sub-parallel.

In thin section (slide 5167) the rock is found to have a fine-grained matrix in which are embedded crystals and fragments of plagioclase and fragments of fine-grained igneous and sedimentary rocks.

It is not possible to determine the minerals in the matrix with complete certainty because they are too fine-grained. Recognizable minerals are feldspar, sericite, and abundant dusty opaque grains, most of which appear to be leucoxene, though some are black, and may be ilmenite or magnetite; the sericite closely resembles that in fragments of shale or slate (see below), and it thus seems likely that the matrix consists of a mixture of igneous and sedimentary material. A few minute curved fragments of feldspar were observed; these help to confirm the tuffaceous character of the rock.

The feldspar crystals and angular fragments consist of partly sericitized oligoclase; its composition is about An_{25}, and some crystals show strong zoning. The sub-parallelism of the long axes of many of the feldspar grains noted in handspecimen is also apparent in the slide.

Rock fragments represented are keratophyre, slate, shale, fine-grained basalt, sericitic silstone, probable fossiliferous limestone, and fine-grained granophyre.

No ferromagnesian minerals are present in the slide examined. Some clots of carbonate (which are at least partly calcite) may represent former pyroxene or amphibole, but this suggestion can not be confirmed. Apart from these no evidence of the former presence of ferromagnesian minerals can be found.

Accessory minerals are black iron-ore and very rare quartz and zircon.

At first it was thought that this rock could be named lithic andesitic tuff, but closer examination suggests that a more suitable name would be lithic keratophyric tuff.

.../2

The fragments of keratophyre are probably derived from the magma which gave rise to the tuff; many of them show trachytic texture and no ferromagnesian mineral can be identified in any of them, though it is possible that small masses of carbonate pseudomorph pre-existing ferromagnesian. The decision to call the tuff keratophyric rather than andesitic is based on three considerations:

1. The presence of fragments of a keratophyre which appears to have had a very low ferromagnesian content.

2. Evidence that very few or perhaps no fragments of ferromagnesian mineral existed in the tuff.

3. The composition of the plagioclase (An_{25}), which is too sodic for normal andesite, though this factor would not be an over-riding one on its own account, because some andesites do contain oligoclase. The composition of the plagioclase becomes significant only when it is considered in conjunction with points (1) and (2).

198W/1
25th January, 1960.

Report No. 5

PETROLOGICAL EXAMINATION OF A BEACH SAND, SUBMITTED BY MR R. BATCHELOR, ROCKINGHAM, W.A.

by W. R. Morgan

The coarse fragments in the sample consist of red silstone; fine-grained acid or intermediate volcanic rock; pieces of clear quartz that enclose portions of coarse, black tourmaline crystals; and lastly, calcareous organic detritus.

The sand was found to consist of the following minerals, in decreasing order of abundance :- quartz, shell fragments, rock grains, garnet and tourmaline, with smaller amounts of magnetite and ilmenite, and rare zircon and rutile.

The garnet and tourmaline are common varieties, and in any case are too small to be of use as gems. The magnetite and ilmenite are not present in large enough quantities for economic exploitation.

66PNG/1
29th January, 1960.

Report No. 6

PETROLOGICAL EXAMINATION OF FOUR BEACH SANDS FROM NEW GUINEA

by

W.R. Morgan

Following is a description of four beach sand specimens submitted by Mr J. Healy, Madang.

Samples P.337, P.338,4 and 5, are rather similar to one another in their mineralogy and in the amounts of minerals present. The weight percentages of magnetite in these samples is listed :-

P.337	3.0
P.338	34.3
4	26.6
5	41.0

As sample 5 contained the most magnetite, it was analysed in detail, and the weight percentages of minerals present were found to be :-

magnetite	41.0
Clinopyroxene	35.9
chromite) ilmenite)	12.8
haematite	2.8
plagioclase	2.1
olivine	1.7
leucoxene	1.6
orthophyroxene	1.0
hornblende	0.3
zircon	0.2
garnet	0.2
tremolite	0.2
monazite	0.1
quartz	0.1
	100.0

In a concentrate of opaque, non-magnetic minerals submitted to Mr W.M.B. Roberts for X-ray spectrographic analysis, about ten times as much chromium as there is titanium was found to be present. As little or no titanium may be contained in solid solution in chromite, it is possible that chromite, and much smaller amounts of ilmenite are present.

Samples P.337, P.338 and 4, were briefly examined, and each was found to have clinopyroxene as the dominant mineral, with much smaller amounts of the other minerals.

Sample P.339 is a very inequigranular sand containing rock grains, feldspar, quartz, heavy minerals, and magnetite. The heavy minerals form 1.6% of the sample, and consist mostly of clinopyroxene, with smaller amounts of olivine, orthopyroxene, and leucoxene. Magnetite forms 0.3% of the sample. The rock grains are composed mostly of fine sedimentary rocks although some fine-grained volcanics are present.

120 A.C.T./1
4th February, 1960

Report No. 7

PETROGRAPHY OF FIVE SPECIMENS OF SLIGHTLY METAMORPHOSED QUARTZ-GREYWACKES

by

W.R. Morgan

These five specimens were collected from the district around Taliesin Homestead, near Queanbeyan, N.S.W. Their localities and thin section numbers are listed as follows :

T.1:	Canberra	1-mile	sheet	324286,	thin	section	number 5020
T.8:	"	"	"	313282,	"	"	" 5021
T.9:	"	"	"	313281,	"	"	" 5022
T.11:	"	"	"	304279,	"	"	" 5023
T.18:	"	"	"	288276,	"	"	" 5024

All the hand specimens are dark grey or greyish-brown, medium-grained but inequigranular micaceous sandstones that show some apparent shearing and lineation of the mica. Specimen T.18 has a phyllite-like sheen on some surfaces.

In thin section, all the specimens are seen to be inequigranular, the grain sizes ranging between 0.02 mm. and 0.5mm. in diameter. All specimens contain angular grains of quartz and subordinate albite that are enclosed in a finer groundmass composed of granular quartz and feldspar, and flakes of sericite and subordinate chlorite. Some perthite grains were noted in specimen T.9, and chlorite seems to be more abundant in specimen T.11 than in the others. The sericite in specimen T.1 is stained by hydrated iron oxide. Black ore is present in specimens T.1 and T.9, and in T.8 and T.11, it is seen to be partly altered to leucoxene. Leucoxene only is present in specimen T.18. Prismatic zircon, and prismatic to anhedral, pale green tourmaline may be found in all the specimens. Sub-prismatic apatite is present in specimens T.9, T.11, and T.18, and sub-rounded grains of sphene in all specimens except T.1. In specimen T.9, euhedral sphene is enclosed in some of the quartz grains.

The textures of the specimens all show the effects of shearing, but it is more pronounced in some (e.g., T.18 than in others (e.g., T.1). The mica and chlorite in specimens T.1 and T.9 tend to be wrapped around the coarse quartz and felspar grains and show only slight lineation. In specimens T.8 and T.11 the lineation is more pronounced. Quartz and feldspar show some strain, and have somewhat ragged margins in specimens T.1, T.8, and T.9. These features are seen to be more pronounced in T.11. Specimen T.18 is definitely more schistose than the others, as it has a pronounced lineation and foliation of sericite and chlorite, and commonly the grains of quartz and felspar have been strained and elongated, and, in places rotated parallel to the cleavage.

All these specimens may be termed greywacke, although from the large amount of quartz present, the name quartz greywacke might be better. Specimen T.18 is an albite-sericite-quartz schist.

120 A.C.T./1
11th February, 1960.

Report No. 8

PETROGRAPHY OF EIGHT SPECIMENS COLLECTED FROM THE GOOGONG DAM-SITE, QUEANBEYAN, N.S.W.

by

W.R. Morgan

The thin sections of eight specimens that were collected at the Googong dam-site in 1954 were submitted by Mr G.M. Burton for petrographical examination. No hand specimens were supplied. The localities, which are listed below, are given in distances and bearings from the south end of the gauging weir at Googong:

1.	127	feet,	on bearing	190°	(magnetic)
6.	175	"	" "	237°	"
7.	290	"	" "	298°	"
22.	525	"	" "	16°	"
23.	520	"	" "	3.5°	"
24.	910	"	" "	4°	"
25.	255	"	" "	135.5°	"
26.	100	"	" "	328°	"

Specimen 1, thin section number 5025

Veined dacite porphyry

Phenocrysts of quartz, andesine, and altered ferromagnesian mineral ranging in size between 0.1 mm. and 5.0 mm. in diameter are enclosed in a fine-grained granular and flow-textured groundmass that has an average grain-size of 0.03 mm. in diameter.

The anhedral quartz phenocrysts are embayed and have pseudo-inclusions: some of the smaller quartzes are angular, and may be pyroclastic. Andesine phenocrysts are tabular to anhedral, and are commonly sericitized; some crystals are strained and microfactured. Subhedral amphibole and biotite are pseudomorphed by epidote, leucoxene, nontronite, and chlorite.

The groundmass is formed of granular quartzofeldspathic material, and leucoxene, and flaky sericite and nontronite. The flaky minerals are strung out in flow trails which swirl around the coarse grains. Octahedra of black iron ore, and prisms of accessory zircon and apatite are present.

The phenocrysts and the groundmass are cut by thin veins containing sericite, nontronite, and rare zeolite. In places, the veins occupy microfractures in the phenocrysts. In the groundmass the veins occur as very narrow diffuse zones in which the flaky minerals are oriented parallel to the flow-texture. The vein minerals commonly form narrow fringes around quartz and andesine phenocrysts.

A visual estimate of the percentages of minerals present is :- andesine: 54, quartz: 25, pseudomorphed ferromagnesian minerals: 10, sericite and nontronite: 10, black iron ore: 1.

.../2

Certain of the angular quartz grains appear to be tuffaceous, although the shapes of most of the phenocrysts, and the presence of the flow-texture suggest that the rock is a lava. It is probable that the rock is a dacite porphyry containing some tuffaceous material.

Specimen 6, thin section number 5026

Devitrified dacitic crystal tuff

Coarse grains of quartz, feldspar, and rare rock fragments and altered ferro-magnesian minerals are enclosed by a fine-grained, dominantly felsitic groundmass.

The coarse grains of quartz are angular, and commonly corroded: they frequently show strained extinction. Oligoclase forms tabular to anhedral crystals that, in some places, occur as interlocking clusters. Oligoclase is somewhat saussuritized. Rare intergrowths of epidote, leucoxene, and chlorite may represent altered ferro-magnesian minerals. A rounded rock fragment, probably trachyte, was observed to be composed of medium-grained tabular plagioclase crowded into a fine-grained felsitic and leucoxenic groundmass.

The groundmass to the grains is composed of finely intergrown felsitic material that is, in places, spherulitic. Minute flakes of muscovite and chlorite, and grains of leucoxene are present. The groundmass probably represents devitrified glass. Accessory apatite and zircon were observed.

The rock is cut by irregular veins containing a fine opaque dust.

Specimen 7, thin section number 5027

Dacite porphyry

This specimen has coarse, anhedral to subhedral phenocrysts ranging between 0.3 mm. to 3.0 mm. in diameter, enclosed in a fine to medium-grained xenomorphic-inequigranular groundmass whose average grain-size is 0.05 mm. in diameter.

The phenocrysts are composed of quartz, plagioclase and rare ferromagnesian minerals. Rarely, quartz occurs as euhedral prisms, but more commonly it forms anhedral, strongly corroded crystals. Plagioclase occurs as tabular-anhedral, somewhat saussuritized and silicified grains. Rare pale green chlorite forms anhedral flakes.

The groundmass is composed of a fine to medium-grained somewhat intergrown grains of quartz and plagioclase. Granular epidote and leucoxene, and flakes of green chlorite are present.

The rock is cut by thin diffuse zones of granular epidote.

Specimen 22, thin section number 5028

Sheared and saussuritized dacite porphyry

Phenocrysts of plagioclase, quartz and actinolitic hornblende are seen to be enclosed in a fine-grained groundmass.

The groundmass is composed of fine, somewhat intergrown quartz and felspar, flaky sericite and chlorite, and granular epidote and leucoxene. In places, a strong lineation in zones seems to have resulted from shearing.

The phenocrysts comprise subhedral, rather strongly saussuritized oligoclase; anhedral, somewhat corroded quartz; and more rare prismatic pale olive-green actinolitic hornblende. Some of the phenocrysts are microfractured, and where they are included in shear zones, quartz and oligoclase have rounded margins, and actinolitic hornblende has been made into flexed fibres.

Zircon, sphene and black iron ore are accessory.

Specimen 23, thin section number 5029

Sheared and veined dacite porphyry

The least sheared portion of the rock is seen to have subhedral to anhedral phenocrysts of quartz and partly saussuritized oligoclase enclosed in a fine-grained groundmass that contains intergrown quartz and feldspar, granular-tabular epidote, and granular leucoxene.

Where the rock is sheared, the phenocrysts have become microfractured and granulated, with quartz showing a pronounced strained extinction. The groundmass quartz and feldspar form highly irregular, intergrown grains.

The specimen is cut by thick, irregular veins composed of yellow epidote.

Specimen 24, thin section number 5030

Sheared and granulated dacite porphyry, or dacitic tuff

In this specimen, coarse shattered and granulated grains of quartz and oligoclase are enclosed in a fine-grained groundmass. The groundmass is composed of quartz and felspar which form granular, commonly elongated and intergrown grains that show a shear fabric. Subhedral to tabular crystals of epidote that are present appear to have been formed subsequently to the shearing.

Specimen 25, thin section number 5031

Dacitic tuff

The specimen contains medium to coarse grains of quartz and feldspar whose sizes range between 0.1 mm. and 2.0 mm. in diameter, enclosed in a fine-grained groundmass. The coarse grains of oligoclase and anhedral to tabular, and many show microfracturing. Quartz forms angular anhedral grains that sometimes show corroded margins. The groundmass is composed of somewhat intergrown grains of oligoclase and quartz. Small amounts of calcite occur in granular aggregates and rare veins.

Specimen 26, thin section number 5032

Veined and saussuritized dacite porphyry

The specimen has coarse phenocrysts of andesine, quartz, and pseudomorphed amphibole, whose sizes range between 0.2mm. and 4.5 mm. They are enclosed in a fine-grained granular groundmass whose average grain-size is 0.05 mm.

Quartz phenocrysts are anhedral, and have embayed margins; several quartzes show strained extinction. Andesine forms tabular to anhedral, often strongly saussuritized crys-

.../4

tals that are commonly microfractured. Amphibole is now pseudomorphed by sagenitic intergrowths of nontronite and black iron ore, and, more rarely, epidote.

The groundmass is composed of fine, granular quartz and feldspar, with minute flakes of sericite. Accessory black iron ore and zircon are present.

The groundmass is cut by numerous thin and irregular veins containing fine flaky nontronite. A few thicker veins of yellow epidote cut the rock.

106G/13/43
12th February, 1960.

Report No. 9

DESCRIPTIONS OF CORES 14, 16, 18 and 20C FROM A.F.O. NO. 1 WELL, DUARINGA 4-MILE SHEET

by

W.B. Dallwitz

Following are descriptions of cores 14, 16, 18 and 20C from A.F.O. Cooroorah No. 1 Well, Duaringa 4-mile sheet.

Core 14, 2925 feet

A fine-grained, greyish black, sedimentary rock which breaks along the bedding surfaces. These surfaces are rather wavy and irregular, and some of them are coated with calcite. Thin, black, wavy, lenticular streaks up to 0.5 mm. wide and 1.5 cm. long are relatively rich in carbonaceous material; they lie parallel to the bedding. Flakes of muscovite are also visible on the bedding surfaces. Abundant minute white grains and a few grains of a bronze-yellow sulphide with a drak brown streak can be distinguished with a lens. In part of the specimen soft, shining black bodies measuring up to 2 mm. are visible; these may be bituminous coal. In parts of core 14D isolated thin lenses and veinlets of (?) marcasite and grains of tarnished chalcopyrite are visible; these later are grouped in small lenses parallel to the bedding surfaces.

In thin section (Slide 5191) the rock is seen to consist principally of angular grains of quartz and feldspar (sodic plagioclase and orthoclase) in a fine-grained sericitic and carbonaceous matrix. The sericite in the matrix shows slight orientation parallel to bedding. The sizes of the quartz and feldspar grains range from 0.3 to 0.015 mm.; their average size is about 0.06 mm., and they make up about 40 percent of the rock.

Thin flakes of muscovite, some of which lie at a high angle to the bedding are prominent but not plentiful; one of these flakes is remarkable in that its ratio of length to thickness is about 100:1(0.75 mm 0.007 mm.).

Accessory minerals are marcasite, biotite, and very rare zircon. The marcasite mostly occurs as clusters of very fine grains; the grains are commonly so closely crowded that the clusters have the appearance of a single grain.

The rock is a carbonaceous, marcasite-bearing greywacke-silstone. The sericitic matrix has probably been derived from original argillaceous material by slight metamorphism. There is no way of deciding whether the metamorphism is due to load-effects or a thermal agency.

Core 16, 3147 feet

This is a slightly brecciated fine-grained, greenish grey rock consisting of fragments measuring from 3 cm. down to a fraction of a millimeter. Fragments measuring less than 0.5 cm. in diameter make up less than 20 percent. of the rock.

These are confined to the crush-zones, which may be up to 1 cm. wide. A mesh-work of dark "veinlets" which are up to 2 mm. wide surrounds the fragments in the crush-zones. Similar "veinlets" penetrate some of the larger fragments outside the crush-zones proper.

In thin section (slide 5190) the fragments are seen to be made up principally of subangular grains of quartz (45%) in a matrix (40%) of sericite, very fine (?) silica, and chlorite. Accessory minerals are acid plagioclase (5%) small flakes of detrital muscovite, chlorite, leucoxene and rare black iron-ore, tourmaline, apatite, and zirzon.

The quartz is much more even-grained than that in core 14, and its average grainsize is about 0.08 mm. A few grains are bordered by an irregular shell which is optically continuous with the enclosed rounded detrital grain. It is, therefore, possible that the angularity of quite a number of quartz grains is due to secondary outgrowths, even though the outlines of original detrital grains can rarely be distinguished.

The spaces between the rock fragments are filled with a rather coarse mosaic of quartz containing a little calcite. The rock in the vicinity of the quartz in-fillings is impregnated to varying distances by chlorite, and veinlets of chlorite extend into the rock for up to a centimeter or so.

No structures or minerals which could certainly be attributed to thermal metamorphism were noted. The rock may have undergone very low-grade regional metamorphism or load-metamorphism. Quartz introduced between the rock fragments and chlorite developed nearby could be attributed equally well to an igneous agency or to conditions existing in a deep fault-zone.

The rock is a <u>brecciated very fine greywacke</u>.

<u>Core 18, 3350 feet</u>

This is a greenish grey, medium-grained massive igenous rock containing a few veins of calcite up to 2 mm. wide.

In thin section (slide 5203) the rock is seen to consist of partly altered plagioclase, actinolite, minor quantities of chlorite, and accessory black iron ore, pyrite, leucoxene, apatite, and sphene. Veinlets and lenticular pockets containing calcite and/or (?) laumontite and/or quartz are conspicuous, and the rock is impregnated with calcite in the vicinity of veinlets rich in that mineral.

The mutual relationships of plagioclase and actinolite suggest that the rock had a sub-ophitic texture. The plagioclase crystals are lath-shaped, and most of them are heavily impregnated with fine-grained actinolite. Because of this impregnation and partial alteration to sericite the composition of the feldspar was rather difficult to determine; however, it appears to be about A_n30-35 (andesine). The actinolite takes two forms - rather stumpy, tabular crystals and irregular masses of fine-grained interlocking fibres; there is no apparent reason for this difference in form, though it is possible that each type may have replaced a different kind of pyroxene.

The rock is <u>uralitized diorite</u>.

Core 20C, 3499 feet

This is a hard, massive, very pale yellowish grey, fine - to medium-grained rock containing abundant but indistinct pale grey flecks.

In thin section (slide 5204) the rock has an unusual appearance, and presents some problems. However, it is quite clear that the rock is igneous; it is an aplite, which may be genetically related to the diorite (core 18) previously described.

About 20-25 percent of the rock consists of spherules of chalcedony, whose size ranges from 0.16 mm. to 0.9 mm. Minute inclusions, a few of which are sericite, give the spherules a clouded appearance. Many of the spherules enclose or partly enclose, centrally or in other positions, one or more crystals of albite. These crystals are usually small (0.06 to 0.3 mm. long) but some are quite large (up to 1.1 X 0.25 mm.), and may have up to three spherules built up round them. In a few places the crystals have been partly replaced by the chalcedony; some crystals are of skeletal form, but it is not possible to say whether this is an original feature or one attributable to corrosion. A number of crystals of subhedral to euhedral albite, making up possibly 5 to 10 percent of the rock, occur independently of the spherules; these are generally much larger than those associated with the spherules, typical dimensions being 0.8 x 0.4 mm., 0.25 x 0.16 mm., 0.64 x 0.4 mm., and 0.1 x 0.1 mm.

There is doubt about the abundance of some components of the matrix in which the spherules and albite crystals are embedded. The average grainsize of the matrix is difficult to determine because of rather marked unevenness in the sizes of the components; however, it is probably about 0.1 mm. The minerals of the groundmass are quartz and albite. Some of the quartz is relatively free from inclusions, and some is crowded with inclusions identical with those in the spherules. The albite is also full of inclusions, which make its appearance the same as that of quartz; the subhedral to euhedral albite mentioned previously is similarly characterized by abundant inclusions.

No ferromagnesian minerals are present. They may be represented by rather sparsely distributed clots consisting of carbonate and minor quantities of leucoxene and sericite. Some of the carbonate is calcite, but some appears to be a rather dark, iron-bearing variety.

Accessory minerals are rare pyrite or marcasite and very rare black iron-ore.

There are two features of this rock that call for comment, viz., the spherules of chalcedony and the cloudy quartz in the matrix. One possibility is that both forms of silica have crystallized directly from a melt, but this suggestion seems rather unlikely, partly because its adoption would make it difficult to explain the difference between the clouded forms of silica and the much clearer form. It seems likely that the clouded quartz in the groundmass and possibly the chalcedony also were formed by replacement of feldspar. As albite appears to have survived quite well, even in small grains, it seems probable that it is potash feldspar that has been replaced.

The rock may be described as a silicified albite-bearing aplite. It is possible that it is genetically related to the diorite (core 18) previously described.

120N/1
15th February, 1960

Report No. 10

PETROGRAPHIC DESCRIPTION AND PYRITE CONTENT OF SAMPLES COLLECTED FROM THE AUSTRALIAN BLUE METAL QUARRY, FEDERAL HIGHWAY

by

W. B. Dallwitz

Samples were collected from a quarry which was just being opened up by Australian Blue Metal Ltd. The quarry is a few hundred yards to the right of the Federal Highway, about 0.6 mile past the A.C.T. border - i.e., about 10 miles from Canberra. The Department of Works was interested in finding the pyrite content of the rock being quarried.

The material being quarried is a medium-grey acid porphyry, which can be described as a chloritized keratophyre or albite rhyolite (see below). No attempt was made to determine whether the rock was intrusive or extrusive.

Pyrite in small amount is unevenly distributed through the rock - as crystals, grains, and aggregates of grains up to 1 cm. across, and (probably rarely) as veins up to 1 cm. or more wide, along small shears and cracks. Under the microscope minute grains of pyrite measuring down to 0.001 mm. were noted. In some specimens very little or no pyrite is visible with the unaided eye, but a few specks can invariably be distinguished with a lens. Barely a little chalcopyrite can be seen.

The rock on the western side of the quarry is somewhat sheared (see below) whereas that towards the east is quite massive.

With a view to getting some idea of the percentage of pyrite in the rock, a grab sample of $-\frac{5}{8}$" + $\frac{3}{8}$" crushed rock was taken from a heap containing several hundredweights. This heap was part of a first small trial crushing, and does, therefore, probably not adequately represent the rock to be quarried.

The sample taken at the quarry was put through a laboratory jaw crusher and disc grinder until the largest particles measured about 1/16". A portion of the ground material was then further reduced to pass through a 60-mesh sieve. S. Baker carried out a chemical analysis for sulphur on the -60 mesh material, and a 20 gm. portion of the same powder was taken for a pyrite separation.

The percentage of sulphur was found to be 0.25, which is equivalent to 0.47 percent FeS_2 (pyrite). To be strictly accurate, this figure should be slightly reduced in the second decimal, because W.M.B. Roberts, in a semi-quantitative X-ray spectrographic analysis, found 200-400 p.p.m. strontium and a smaller quantity of barium in the sample; the fact that some of the sulphide in the rock is chalcopyrite would also alter the figure very slightly. If there is any sulphate in the sample (e.g., gypsum or

ferric sulphate) a further correction would have to be applied. However, the net sum of all these corrections would almost certainly be so small as to be negligible for all practical purposes.

Pyrite was separated using the superpanner and bromoform, and allowance was made for other "heavy" minerals that came out with the pyrite. Strongly magnetic minerals and iron fragments from the crushing and grinding apparatus were separated magnetically under water. By this method the percentage of sulphide (including some chalcopyrite that could be distinguished by its tarnish) was found to be 0.4. This accords quite well with the chemical result (0.47% FeS_2), considering that pyrite occurring as composite grains and as very minute dust-like grains (see above) would not have been separated. Heavy minerals separated with the pyrite are apatite, zircon, limonite, haematite, leucoxene, epidote, ilmenite, chlorite, and garnet, approximately in that order of abundance.

As there is some tendency for the pyrite to occur along cracks and, probably rarely, along shears, it was to be expected that there would be some concentration of sulphide in the finer fractions of crushed material. To check this the rock as taken from the laboratory disc grinder (largest pieces about 1/16") was sieved, and it was found that 80% stayed on a 60-mesh sieve. Using the superpanner and bromoform the 20% which passed through the sieve was found to contain 0.8% pyrite (double the percentage found in the whole rock).

Following are results of sulphur determinations carried out by A. Fricker on seven additional samples :

Sample No.	Description (mesh size)	Date Collected	Percentage Sulphur	Equivalent Percentage pyrite (calculated)
1.	$\frac{5}{8}$"	Between 24/11/'& 2/12/59	0.24	0.45
2.	$\frac{7}{8}$"	"	0.17	0.32
3.	$\frac{7}{8}$"	2/12/59	0.18	0.33
4.	$\frac{5}{8}$"	"	0.17	0.32
5A.	$-\frac{5}{8}$"(normal fines)	"	0.09	0.17
5B.	$-\frac{5}{8}$"(very fine material)	"	0.09	0.17
6.	- 2"(total rock ex primary & secondary crushers)	"	0.10	0.19

The average sulphur content of these samples is 0.15% which is equivalent to 0.28% pyrite. As far as these analyses are concerned, the suggested indication that more pyrite would be found in the fine fractions was not confirmed - in fact, the reverse condition appeared to be true. However, because of the manner in which the samples were taken, no final statement on distribution of pyrite in the different fractions from the crushing and sizing of a selected quantity of rock to decide this point. The matter is of some interest because of the advantages that could, under certain circumstances, follow from relative concentration of pyrite in the finest fraction, which is normally not used as aggregate for

concrete. However, as the percentage of pyrite appears to be below 0.4%, this consideration is scarcely worth taking into account on the present showings.

Brief descriptions of the massive and sheared rocks, as exposed in the quarry on 18th November, follows :

I. Massive albite rhyolite, E side of quarry. Slide 5007.

This is a grey rock containing porphyritic crystals of feldspar and quartz, measuring up to about 5 mm., in a fine-grained groundmass. Dark clots up to 7.5 mm. long and scattered grains of pyrite are also visible.

In thin section the rock is found to consist essentially of subhedral crystals of albite (An_4), corroded, strained, and fractured grains of quartz, and chlorite-leucoxene masses embedded in a felsitic groundmass of alkali-feldspar, chlorite, and quartz. Primary accessory minerals are apatite and rare zircon. A little sericite is associated with many of the chlorite-leucoxene masses, and a few thin sericite veinlets resembling stylolites in form traverse the slide.

Many of the albite crystals contain inclusions of chlorite and nearly all carry a little sericite. Most of the chlorite - leucoxene bodies appear, from their form, to have pseudomorphed biotite. A few of them contain hardly any leucoxene, and it is possible that these pseudomorph some other ferromagnesian mineral.

A few minute grains of carbonate are associated with some of chloritic pseudomorphs.

II. Sheared albite rhyolite. W side of quarry. Slide 5006

This rock has a rough cleavage and contains numerous dark grey streaks whose long axes have a sub-parallel alignment. In the quarry face the rock is seen to be more deeply weathered than the massive rhyolite.

Differences in the appearance of this rock, as compared with the massive variety, are attributable to shearing. Quartz is more strongly strained and fractured, and a number of the larger albite phenocrysts have been shattered and strained with little disturbance of their general outlines. The dark streaks noted in handspecimen consist of chlorite pseudomorphs drawn out in the direction of cleavage; on the whole very much less leucoxene accompanies the chlorite. Sericite is quite strongly developed along some shear-surfaces.

Comment on rock name

If this rock is intrusive it should be called a quartz-albite porphyry. However, considering the apparent size of the body, the grainsize of the groundmass is such that the rock is rather more likely to be volcanic. On present evidence nothing more definite can be said from petrographic evidence alone.

120 A.C.T/1
16th February, 1960.

Report No. 11

THE PETROGRAPHY OF EIGHT SPECIMENS COLLECTED IN THE SUTTON-QUEANBEYAN AREA, A.C.T.

by

W.R. Morgan

These specimens were collected by Dr D. Moore in 1957, while he was mapping this area. The thin sections were submitted for examination by Mr E.G. Wilson. The specimens are listed with their localities:

258	-	Canberra	1-mile	sheet 225388
310a	-	"	"	" 253380
310b	-	"	"	" 253380
310c	-	"	"	" 253380
316	-	"	"	" 256387
319	-	"	"	" 259379
322a	-	"	"	" 261379
322b	-	"	"	" 261379

Specimen 258, slide number 5075

Sheared quartzite

The thin sections shows the rock to be a medium to coarse-grained, inequigranular sandstone in which the grain sizes range from 0.1 mm. to 3.3 mm. in diameter. The rock is composed almost entirely of quartz, but very minor amounts of sericite, albite and microcline are present.

Quartz forms somewhat interlocking, sub-angular grains that show some parallel elongation, and which have strained extinction. Quartz has numerous minute inclusions which form a rough network through the grains and across the rock. Fine flakes of sericite occurs as an extremely sparse intergranular matrix: more rare chlorite is also present. Fine, angular grains of albite and microcline are uncommon. Zircon, leucoxene and black iron ore are accessory. Rare grains are composed of finely intergrown quartz, and sericite, respectively. Some cubic crystals now composed of hydrated iron oxide probable represent pseudomorphs of pyrites. The rock is cut by thin veins of quartz, and hydrated iron oxide.

Specimen 310a, slide number 5076

Greywacke

The specimen is a fine to medium-grained, inequigranular rock whose grain-sizes range between 0.03 mm. and 0.75 mm. in diameter. Angular to sub-angular grains of strained, sometimes granulated quartz, and strained and microfractured oligoclase are enclosed in a matrix of fine flakes of greenish-brown biotite and colourless sericite. Leucoxene grains are irregular, and zircon is accessory.

A visual estimate of the amounts of minerals present is :- quartz: 60, oligoclase: 10, mica: 28, leucoxene: 2.

Specimen 310b, slide number 5077

Sheared greywacke

The specimen comprises 68% quartz, 15% sericite, 15% oligoclase, and 2% leucoxene, with accessory zircon and tourmaline. Quartz and felspar form fine to medium-size sub-rounded and commonly elongated lenticular grains that have a sub-parallel orientation. Extremely fine flakes of sericite form trains that are wrapped around quartz and felspar. Rare leucoxene occurs as elongated streaks. Zircon and green tourmaline are accessory.

Thin bands of granulated quartz run parallel to the grain elongation. A vein composed of granular quartz cuts across the shear direction.

Specimen 310c, slide number 5077

Tuffaceous shale

The specimen is fine-grained and cleaved, and contains rare coarse grains of euhedral sericitized felspar, around which the cleavage is wrapped. The fine material comprises lineated flakes of green chlorite and rarer sericite, and granular quartz, plagioclase and leucoxene. Plagioclase forms coarse, tabular and strongly sericitized crystals whose sizes range from 0.03 mm. to 1.0 mm. in diameter. These crystals have no common orientation. More rarely, cubes of pyrites, commonly partly or wholly altered to hydrated iron oxide, are present. The specimen is cut by thin veins composed of oligoclase and quartz.

Specimens 316 and 319, slide numbers 5079 and 5080 respectively

Greywackes

Specimen 316 is a medium-grained rock composed of inequigranular, sub-angular to sub-rounded grains of quartz and oligoclase set in a fairly abundant matrix of fine flakes of pale brown biotite, and sericite. Hydrated iron oxide is present as an intergranular dust, and forms octahedral crystals, probably pseudomorphing pyrites. Zircon, apatite and green tourmaline are accessory.

Specimen 319 is rather similar, except that the grains of quartz and oligoclase are set closer together, and the micaceous matrix is more sparse. Zircon, apatite and green tourmaline are accessory. Some leucoxene was also observed.

Specimen 322a, slide number 5081

Brecciated, veined and altered quartz diorite

The specimen is inequigranular, the grain sizes ranging from 0.25 mm. to 1.4 mm. It is xenomorphic to hypidiomorphic, and some microfracturing and shearing may be seen, superimposed upon the igneous texture. In the unsheared portions of the rock, tabular oligoclase (An_{25} - 30) crystals that are somewhat clouded by alteration products are seen to be partly enclosed by grains composed of nontronite, chlorite and leucoxene. These intergrown ferro-magnesian minerals may represent pseudomorphed pyroxene. More rarely

an interstitial microgranophyric intergrowth of quartz and felspar is present, partly enclosing, and, in some cases, replacing oligoclase. Minute prisms of apatite are accessory.

The oligoclase crystals commonly show strained and microfractured multiple twinning, and thin zones of granulated material cut the rock.

Thick, irregular veins composed of coarse, granular quartz and albite are present.

Specimen 322b, slide number 5082

Breccia

The specimen is exceedingly inequigranular grains, their sizes ranging from 0.01 mm. to 4.0 mm. in diameter that are embedded in a very fine matrix, whose average grain size is 0.005 mm. in diameter. The grains are sub-angular to sub-rounded, and the smaller ones are composed of quartz and rather tabular oligoclase. The coarser grains are rock fragments, and are composed of apparent greywacke, or tuffaceous material, and of intergrown quartz. The matrix material is composed of fine flakes of chlorite, and grains of quartz and plagioclase.

106G/13/54
25th February, 1960.

Report No. 12

PETROGRAPHIC DESCRIPTION OF A CORE SAMPLE FROM THANGOO, W.A.

by

W. B. Dallwitz

Following is a description of core 9, at 5256' - 5266', Thangoo No. 1A well, La Grange 4-mile sheet, Western Australia:

The rock is dark grey, fine-grained, and well-cleaved. Thin layers of yellow sulphide occupy some of the cleavage planes, and veinlets and small pockets containing quartz and sulphides are plentiful; the veinlets run in at least four different directions. One vein of sulphide-bearing quartz is very much larger than the rest, and measures up to 2.5 cm. across.

In thin section (slide 5304) the rock is seen to be a phyllite. It consists essentially of sericite and subordinate quartz; the quartz grains are of silt size. Scattered through the rock are small (up to 0.11 x 0.04 mm.) prisms of brown tourmaline and leucoxene pseudomorphs after prismatic crystals of rutile; the average size of the pseudomorphs is about 0.15 x 0.03 mm. Most of the prisms of leucoxene and tourmaline lie parallel or sub-parallel to the cleavage, but the long axes of some make a high angle with the cleavage.

The veinlets and pockets noted in handspecimen contain quartz, pale yellow-grey chlorite, dolomite, sulphides (mainly pyrite) and very rare apatite, sericite, biotite, and tourmaline.

W.M.B. Roberts has reported as follows on the opaque minerals in the large vein of quartz referred to in the description of the handspecimen:

> "Pyrite is by far the most abundant sulphide. Next in order are sphalerite, pyrrhotite, chalcopyrite, marcasite, galena, and arsenopyrite. Pyrite forms small cubes ranging up to 0.02 mm. across, and large irregular masses up to 15 mm. in width. Sphalerite occurs as a small vein filling, 0.6m. long and 0.1m. wide, with which are associated irregular areas of chalcopyrite and pyrrhotite. Galena forms an almost perfect cube of 0.02 mm. edge enclosed in the sphalerite vein, and arsenopyrite occurs as small isolated clusters of euhedral and subhedral crystals, the largestof which is 0.04 mm. across. Only one crystal of marcasite 0.1 mm. across was observed in the section; it is associated with pyrite."

Comments

This rock belongs to the greenschist facies of regional metamorphism. It has been invaded by mineralizing

fluids which have deposited, among other things, tourmaline, apatite, pyrrhotite, and arsenopyrite. The presence of these minerals implies the existence of an igneous source and, as a corollary, the absence of any incentive to pursue the search for oil to a greater depth unless there is a distinct possibility that the drill is sited on a block which has been raised by reverse or thrust faulting.

106G/13/45
1st March, 1960.

Report No. 13

PETROGRAPHIC DESCRIPTION OF A CORE SPECIMEN ~~FROM~~ FROM BETCOTA, QUEENSLAND

by

W. R. Morgan

Herewith is a brief description of the petrography of a core specimen from 4786 feet in a drill hole that is being put down at Betcota, Queensland, by Delhi Australian Petroleum Ltd.

The hand specimen is a medium- to coarse-grained, somewhat friable, dull mauve - red quartz sandstone that contains rare grains of brownish-red garnet. The identification of this mineral is the reason for this report.

In thin section the rock is seen to be fairly equigranular, although the grain sizes range from 0.15 mm. to 1.05 mm. The grains are sub-angular, and mostly consist of quartz showing strained extinction and, more rarely, granulation. Small amounts of partly altered felspar, and grains of green chloritic material are present. Pale pink garnet, possibly almandine, is accessory, and forms sub-angular grain. Fine-grained granular carbonate is interstitial. The carbonate does not react with dilute HCl, therefore thought to be dolomite. The rock is a quartz sandstone.

198PNG/1
3rd March, 1960.

Report No. 14.

EXAMINATION OF A MINERAL SPECIMEN FROM THE UPPER RIDGES MINE, N.G.

by

W.M.B. Roberts

The specimen of dark, silver-grey, friable material was submitted by M. Plane, of Wau, N.G. office. It has a radially fibrous structure, it is greasy to the touch, and it soils the fingers in a manner similar to that of graphite.

The mineral lost 66% of its weight on heating at 110°C for 2 hours. A portion of the dried material was mounted in plastic under a vacuum and then polished; no minerals capable of reflecting light were observed. A thin section proved to be completely opaque.

An X-ray powder diagram showed a broad diffuse halo on which were superimposed two weak, incomplete lines; the only information obtainable from this was that the material has very little crystal structure.

An X-ray spectrographic analysis identified the principal constituents as Mn, Fe and Zn, with strong traces of Cu, Pb, As, Sr, and Ba.

The poor crystallinity, radially fibrous structure, and earthy appearance, coupled with the X-ray analysis showing theprincipal constituent to be Mn, identifies the material as wad.

The fairly high proportion of zinc present suggests that the specimen is a zinciferous variety; probably tunnerite, which has been reported from Bleiberg, Carinthia, Germany.

Dana* states that one of the common occurrences of wad is in the oxidised parts of ore deposits, where it is a common alteration product of manganese minerals. Its occurrence in vugs, associated with mangano-calcite, in the mine, and in fractures in the adjoining schist, suggests that this is the origin of this particular mineral.

References

* Palache, Berman & Frondel - Dana's System of Mineralogy, Seventh Edition, Vol. 1 p. 570.

12ONT/10
17th March, 1960.

Report No. 15

DAVENPORT RANGE - ROCK DESCRIPTIONS

by K.R. Walker

DR26 - Hand Specimen:

The rock is red-brown, and has a massive igneous appearance, and a sub-conchoidal fracture. It is porphyritic; phenocrysts of pink feldspar and quartz are evenly distributed in the aphanitic groundmass. In a fresh surface minute mica flakes fleck the groundmass. The weathered surface is iron-stained and forms a yellow-brown crust on the rock.

Thin Section:

In thin section the rock can be seen to be porphyritic, glomerophorphyritic, and granophyric. Phenocrysts of plagioclase and quartz are set in a delicate feathery granophyric base. The quartz phenocrysts are generally corroded and measure up to 1.5 mm., and those of plagioclase are subidiomorphic or idiomorphic and measure up to 2 mm; they are in optical continuity with their corresponding component in the surrounding intergrowth; one of the plagioclase crystals is strongly corroded. The feldspar of the intergrowth is light brown; needles or rays of quartz which form feathery intergrowth with it are up to 0.3 mm. long. Numerous spherulites are in the granophyric groundmass and these measure up to 0.5 mm. diameter. Throughout are small opaque iron mineral grains and flecks of white mica. Rare small zircon and apatite grains occur throughout.

The plagioclase in the phenocrysts is oligoclase and is twinned mostly according to the albite law. Phenocrysts are fairly fresh, though flecked with sericite. The feldspar in the base has a light brown clouding.

The rock is a granophyric quartz-oligoclase porphyry.

DR34. Hand Specimen:

The rock is a dark grey, massive basic igneous rock. It is medium-grained and consists mainly of dark green hornblende and cream plagioclase. Fine pyrite grains occur throughout.

Thin section:

The rock in thin section can be seen to be blastophitic, and to consist almost entirely of plagioclase and uralitized pyroxene. Subordinate amounts of hornblende, biotite, quartz and opaque iron mineral are present. The feldspar laths measure from 1 to 3 mm. long and the ferromagnesian mineral grains range between 1 and 4 mm. across; both occur in roughly equal amounts.

The plagioclase crystals are idiomorphic and lath-shaped, or tabular. Both simple and complex twins are common and measurements on two crystals with albite-Carlsbad twins indicate compositions of Ab_{32} An_{68}, and Ab_{34} An_{66}. Many crystals are zoned and undulose extinction is also prevalent. Alteration, mostly of adjacent ferromagnesian minerals, re-

sulted in the development of uralitic amphibole along feldspar cleavages.

The ferromagnesian grains are mostly cores of pyroxene within uralitic amphibole - or are original pyroxene rimmed with amphibole. However, alteration to amphibole has also occurred along cleavages. These grains are sub-idiomorphic or xenomorphic, as are those of hornblende that occur in small numbers when alteration has been slightly more extensive. In the original pyroxene, and in the partly uralitized grains, relict schiller structures can be seen. The small inclusions forming this structure appear to be altered to amphibole.

Of the minor constituents, opaque iron mineral is the most abundant, and grains measure from 0.5 to 2mm. Biotite flakes are also evenly distributed throughout and they measure from 0.2 to 1 mm. Quartz forms irregular interstitial grains.

The rock is an autometamorphosed dolerite or it is a dolerite that has undergone very low grade metamorphism. This alternative is supported by the undulose extinction and slight granulation of wavy feldspar grains, and also by the development of amphibole in their cleavages and cracks. However, feldspar alteration involves no more than slight flecking with sericite; feldspar has probably changed little from its primary composition.

DR40. Hand Specimen:

The rock is fine-grained and granitic; it is coloured pink by the feldspar. Sparse phenocrysts of feldspar measure up to 10 mm. Feldspar, quartz, biotite, and muscovite can be identified in hand specimen. Quartz is translucent grey, and the micaceous minerals are widespread, forming, in places, clots.

Thin section:

In thin section the rock can be seen to be allotriomorphic granular. It consists mostly of microcline, plagioclase, quartz, biotite and muscovite. The accessory minerals are apatite and an epidote mineral. There is a wide range in grainsize from less than 1 mm. up to 3 mm; generally, the microcline grains are larger than those of quartz, and the muscovite flakes are considerably larger than those of biotite.

Quartz mostly forms irregular interstitial grains that measure from 0.5 to 2 mm; it shows strong undulose extinction and partial granulation.

The plagioclase is the most abundant feldspar; most grains are xenomorphic and turbid brown; they contain indistinct albite twin lamellae which may be flexed and show strain. A direct determination of the composition of the plagioclase is not possible, but as its R.I. is slightly greater than that of Canada balsam, it is probably oligoclase.

Microcline is slightly perthitic and forms xenomorphic grains that show fairly coarse grid iron twinning, and only slight alteration.

Flakes of biotite average about 0.5mm. in size, and are pleochroic from dark greenish brown to buff. Much of the biotite is strung out as if occupying fractures. Pleochroic haloes are common and granular epidote occurs in close association with groups of biotite flakes. The muscovite almost everywhere shows signs of distortion.

A micrometric analyses by point counter of the thin section shows that it is composed of 31.9% quartz, 29.5% plagioclase, 27.1% microcline perthite, 6.9% muscovite, 4.7% biotite.

The rock is an adamellite, but it has certain affinities with an alkali granite in its abundance of muscovite.

DR.41. Hand Specimen:

The rock is a mauve brown, massive acid volcanic that breaks with a conchoidal fracture. Small feldspar phenocrysts can be recognized in the aphanitic groundmass. The weathered surface is pitted and iron-stained.

Thin Section:

In thin section it can be seen that sub-idiomorphic feldspar phenocrysts are evenly distributed in an incipiently recrystallized base of quartz and feldspar. Small bundles of biotite flakes, which measure up to 0.2 mm. across, are evenly distributed throughout the base. The phenocrysts range in size from 0.5 to 2.5 mm. in diameter. The groundmass is silicified and contains irregular quartz grains that average 0.15 mm. across. Aggregates of quartz form patches up to 1 mm. across and these are probably recrystallized quartz phenocrysts. The feldspar phenocrysts are albite, as their R.I. is below that of Canada balsam; they are twinned according to the albite law.

Accessory minerals are chlorite, hornblende, apatite, zircon, sphene and opaque iron mineral. The opaque iron mineral is fairly widely distributed throughout in this section.

The rock is a silicified albite rhyolite; accurate naming, however, is made difficult by the fineness of the groundmass and thus by the lack of identification of minerals. There is a paucity of dark minerals.

DR.42. Hand Specimen

The rock is dark grey. It is massive and breaks with a conchoidal fracture to expose flesh-coloured feldspar phenocrysts (up to 2 mm. in diameter) in a dark aphanitic groundmass. The weathered surface of the rock is buff-green and spotted with slightly weathered feldspar crystals.

Thin Section:

In thin section the texture is seen to be porphyritic; most phenocrysts are plagioclase. Plagioclase crystals also form glomeroporphyritic patches. In one case a group of xenomorphic plagioclase grains forms a rounded mosaic, and may therefore have been a rock fragment caught up in the magma. The groundmass is finely crystalline and consists mainly of quartz and possibly some plagioclase. It comprises quartz with abundant sericite and some biotite, and the average grainsize of the irregular quartz grains is 0.15 mm. in diameter. Biotite, however, also forms bundles of criss-cross flakes which may pseudomorph original ferromagnesian minerals or is strung out in trains forming an irregular network. Accessory minerals are calcite, opaque iron mineral, chlorite, sphene, apatite, and zircon.

Most phenocrysts are idiomorphic and measure up to 3 mm. The plagioclase has a positive 2V and an R.I. slightly greater than that of Canada balsam, which indicates its composition is albite-oligoclase. It shows variable sericitization. The phenocrysts form 20% of the thin section and biotite 10%. The remainder is groundmass.

The rock is a silicified dacite.

DR43. Hand Specimen:

The rock is an acid volcanic. The weathered surface is flesh pink and spotted with feldspar phenocrysts. The rock breaks with a sub-conchoidal fracture and exposes a red-brown surface showing feldspar phenocrysts in an aphanitic groundmass. A few quartz phenocrysts can be recognised. The feldspar phenocrysts measure up to 3 mm.

Thin section:

The thin section of the rock is porphyritic; most phenocrysts are plagioclase and the remainder are quartz. Those of plagioclase measure up to 2.5 mm. in diameter and those of quartz up to 1 mm. across. The phenocrysts are set in a finely crystalline groundmass which appears somewhat feathery, as much of the intergrown quartz and alkali-feldspar forms narrow and branched grains. Although the thin section is holocrystalline, resolution of crystal margins is difficult, even under high power. Fine white mica flakes are scattered throughout the groundmass.

The plagioclase is albite-oligoclase; it is more or less evenly flecked with minute flakes of sericite.

Quartz phenocrysts are corroded, have pseudo-inclusions, and show undulose extinction.

Accessory minerals are zircon, opaque iron mineral, biotite, and sericite. The opaque iron mineral is widespread.

Estimate of mineral percentages can only be roughly made. Plagioclase phenocrysts form 10% and those of quartz 5%, and of biotite 3%. The groundmass forms 10%, and quartz and feldspar each 35%, of the rock. The accessory minerals account for the last 2%.

The rock is a metadacite whose alteration is low-grade regional.

DR44. Hand Specimen:

The rock is an acid volcanic which has a rust-stained and flesh-coloured weathered surface that contains weathered feldspar phenocrysts. It breaks with a conchoidal fracture and exposes a dark brown surface containing numerous pink feldspar phenocrysts that measure up to 4 mm. across. They occur in an aphanitic groundmass with evenly distributed small biotite flakes.

Thin Section: The thin section shows that the rock is porphyritic. The phenocrysts are idiomorphic oligoclase crystals that measure up to 3 mm. in diameter. Biotite phenocrysts are widespread and smaller; they form single flakes or are grouped together in bundles. The groundmass consists of finely crystalline quartz and feldspar, and contains numerous

small biotite and chlorite flakes. The intergrowth of quartz and feldspar grains tend to be feathery. However, complete resolution of all grains in the groundmass is difficult. Accessory minerals are zircon, sphene, epidote, hornblende, calcite and apatite. Opaque iron mineral is widely distributed throughout; some grains measure up to 0.5 mm., but most are much smaller.

Most biotite flakes are pleochroic from light golden-brown to dark green-brown. Alteration to chlorite along the cleavages is common. The chlorite also forms individual flakes that are strongly pleochroic from pale to rich lettuce-green.

The rock is a metadacite which has undergone low-grade regional metamorphism.

DR47. Hand Specimen:

The rock is granitic and consists of pink feldspar, translucent quartz and muscovite; biotite can be recognised also. It is partly weathered and inclined to disintegrate into grains of its component minerals. The rock is medium-grained; grains average about 5 mm.

Thin Section:

The thin section shows that the rock is allotriomorphic granular and that it consists mainly of quartz, plagioclase, microcline-perthite muscovite, and biotite. Many of the grains are fractured and partly granulated; the grainsize ranges from 1 to 5 mm. in diameter. Secondary minerals are sericite and chlorite.

Quartz grains measure up to 5 mm; they are fractured and show undulose extinction. Moreover, partial granulation has resulted in some of them being traversed by feathery fractures.

The feldspar is mostly microcline-perthite and perthitic microcline; grains range up to 5 mm. They show typical grid-iron twinning and well-developed cleavage. Many irregular cracks traverse them, and these in some cases are occupied by biotite. The plagioclase is oligoclase; it generally contains numerous albite twin lamellae. These are bent in many grains.

Muscovite flakes measure up to 5 mm. long but many are smaller. *s they are strongly cleaved it can be seen that they are flexed. Biotite has grown along some cleavages; some of it is altered to chlorite; opaque iron mineral is associated with it in some places. Both biotite and chlorite contain numerous small pleochroic haloes. The biotite is pleochroic from pale brown to green-brown.

The thin section consists of 35% quartz, 30% microcline-perthite, 25% plagioclase, 7% muscovite, and 3% biotite. This is a visual estimate only.

The rock is an adamellite.

DR51. Hand Specimen:

The rock is massive and appears to be basic igneous. It is so fine-grained, that individual minerals cannot be readily identified. Facets of ferromagnesian minerals and feldspar can be recognized with difficulty. The rock has an iron-stained weathered surface.

Thin Section:

The thin section has an intergranular texture and contains glomeroporphyritic patches of feldspar laths. It consists mainly of plagioclase, uralitic amphibole, epidote, and chlorite. Accessory minerals are opaque iron mineral, sphene, quartz and prehnite. Most plagioclase laths measure about 0.5 mm. long, but laths in the glomeroporphyritic patches, and also some individual laths, measure up to 1 mm. Most interbedded uralitic amphibole grains are less than 0.2 mm. across; a few pseudomorphs, however, measure up to 1 mm. long.

The plagioclase is oligoclase - andesine laths are idiomorphic or sub-idiomorphic. Much of the twinning preserved is according to the albite law. Alteration is to epidote; most laths contain small grains of this mineral and show undulose extinction.

The coloured minerals are uralitic amphibole, epidote, and chlorite. These occur interstitially, but, as mentioned, epidote is included within many plagioclase laths.

The uralitic amphibole tends to be fibrous, pale, and only slightly pleochroic. Uralitization of the original ferromagnesium minerals has resulted in the formation of some quartz as a by-product.

The rock is a fine-grained basalt or dolerite which has undergone low grade regional metamorphism. It is probably best-called a metabasalt. The original feldspar would have been more basic; lime has gone to make up, with some of the magnesia from original ferromagnesian minerals, epidote and chlorite. Much of the opaque iron mineral has been converted to sphene. Reconstitution, however, was insufficient to result in stress causing a lineation of mineral grains; but stress is evidenced in the feldspar laths by their undulose extinction, fracturing, and bent twin lamellae.

DR52. Hand Specimen:

The rock is fine-grained and of basaltic appearance. It is massive, and breaks with a sub-conchoidal fracture to expose a medium grey surface. Its weathered surface is iron-stained.

Thin Section:

The thin section consists essentially of altered feldspar laths and interstitial epidote, uralitic amphibole, and chlorite. Original pyroxene forms cores within uralitic amphibole. There are a number of penninite-filled cavities with idiomorphic inclusions of epidote. The laths range up to 2 mm. long and most interstitial grains rarely exceed 1 mm. across, and have indefinite grain margins. Accessory minerals are opaque iron mineral, sphene, calcite, apatite, and quartz.

Most of the feldspar laths are pitted with small epidote and chlorite inclusions. Much of the twinning has become indefinite; the R.I. of the feldspar indicates that it is probably acid oligoclase.

Most of the original ferromagnesian minerals have been altered to uralite, chlorite is another product of alteration, and, with epidote, also forms the cavity fillings.

Opaque iron mineral grains average about 0.2 mm. across and are evenly distributed throughout; skeletal grains suggest it is ilmenite.

The rock is a slightly metamorphosed or an autometamorphosed dolerite.

DR107. Hand Specimen:

The rock is a buff-grey silstone. Its weathered surface is dark rusty-brown. The fracture of the rock is partly controlled by the poor cleavage. The rock is too fine-grained for individual minerals to be identified.

Thin Section:

The thin section is finely micaceous and has a poor schistosity. The lineation of mica flakes may parallel original bedding planes; numerous quartz and feldspar grains are evenly distributed throughout. These measure up to 0.1 mm. whereas the mica flakes are much smaller. Feldspar is an important component; grid iron twinning indicates that some opaque iron mineral grains are widespread; these include some magnetite idioblasts (0.1 mm. diameter). Accessory minerals are green tourmaline, apatite, hornblende, leucoxene, and epidote.

The thin section is cut by a siliceous vein 0.1 mm. wide.

The rock is a siltstone.

DR131. Hand Specimen:

The rock is massive and has a rusty-brown weathered surface in which cream weathered plagioclase crystals that measure up to 8 mm. across can be seen. The rock has an irregular fracture and its fresh surface is green-grey. Within the grey fine groundmass, cream plagioclase phenocrysts and green epidote grains can be identified.

Thin Section:

The thin section is that of a porphyritic basic igneous rock with numerous amygdules. The plagioclase phenocrysts are idiomorphic and measure up to 3 mm. across; they are set in a groundmass of feldspar microlites and of fine actinolitic needles. Glomeroporphyritic patches of feldspar also occur. The amygdules dominate the texture and consist of epidote with or without quartz or chlorite; they have layered structures, and measure up to 5 mm. in diameter. That is, some have a core of chlorite bordered by a shell of epidote. Fine opaque iron mineral grains are scattered throughout the base. Accessory minerals are calcite and biotite. Calcite occurs in amygdules and in feldspar.

The plagioclase is oligoclase, and that in phenocrysts contains albite lamellae, as well as complex twin sub-individuals. Crystals have a light brown clouding.

The rock is a porphyritic and amygdaloidal oligoclase basalt; whose alteration is deuteric or extremely low grade regional.

DR133. Hand Specimen:

The rock breaks with an uneven fracture and exposes a medium green-grey surface. It is a fine-grained basic rock that contains cream plagioclase phenocrysts randomly distributed throughout; feldspar and amphibole can be identified in hand specimen. Its weathered surface is rusty-brown and contains protruding weathered cream feldspar phenocrysts.

Thin Section:

The thin section is ophitic and consists mainly of plagioclase, pyroxene, and abundant secondary chlorite, sericite, epidote and sphene. Accessory minerals are quartz and opaque iron mineral (probably magnetite and ilmenite). Quartz occurs mainly in the mesostasis, where it is commonly intergrown with alkali - feldspar. Most of the plagioclase forms laths, but feldspathic patches now extensively saussuritized, were probably also plagioclase phenocrysts. Sericite and epidote are abundant in these patches. Grainsize averages about 1 mm.

Sericitization of plagioclase makes the determination of its composition difficult. A few relict grains indicate a composition of about Ab_{55} An_{45}.

The pyroxene is an augite with a moderate positive 2V. Some of it is altered to uralitic amphibole and chlorite.

This rock is a dolerite that is essentially autometamorphosed, but which may have suffered slight dislocation metamorphism. This is indicated by fractures and slight granulation of some grains; such a condition possibly also resulted in some uralitization and sericitization.

DR138. Hand Specimen:

The rock is red-brown and igneous, and is somewhat iron-stained; feldspar phenocrysts are weathered and flesh-coloured. A freshly broken surface shows that quartz and the feldspar phenocrysts are set in an aphanitic groundmass; phenocrysts of quartz are smaller than those of feldspar that measure up to 4 mm. across. Also in the groundmass are numerous small (0.5 mm. diameter) red spots, closely spaced, which are that part of the groundmass impregnated with finely divided hematite.

Thin Section:

The thin section contains plagioclase phenocrysts in a partly granophyric groundmass; these measure up to 2 mm. The red spots, some of which are nearly opaque red, can be seen to be brown-stained oligoclase spherules; some of them are partly silicified. The spherules measure up to 0.5 mm. in diameter. Some of the spherules are completely siliceous, but these are not iron-stained, and are readily identified by their uniaxial figure. The various spherules are abundant and randomly distributed.

The groundmass contains numerous clear xenomorphic quartz grains and albite laths; some of these laths penetrate, or are included in, the spherules. Lesser constituents are chlorite, sphene, and opaque iron mineral; flecks of chlorite are concentrated around grain margins. Sericite flecks of chlorite are concentrated around grain margins. Sericite flecks the surface of the plagioclase, and some of the phenocrysts contain numerous quartz inclusions as a result of their silicification.

The rock is a feldspar porphyry that has certain granophyric affinities in that its groundmass contains late stage crystallization products, spherulitic-plagioclase and quartz, and patches of crush quartz-feldspar intergrowth. However, it has been extensively silicified.

DAVENPORT RANGES - NAMES AND MINERAL CONTENT OF ROCKS AS REQUESTED

DR33. Uralitized and Saussuritized gabbro pegmatite:

The thin section mainly consists of saussuritized plagioclase, uralitized pyroxene quartz, and opaque iron mineral. Ilmenite in the pre-existing opaque iron mineral is altered to sphene, leaving grains with relict magnetite blades. Epidote is an abundant component of the saussurite. Grains are even and average about 4 mm.

DR38. Granophyric rhyolite porphyry or granophyric porphyritic rhyolite:

The thin section is essentially a micrographic intergrowth of quartz and potash feldspar in which a few quartz and plagioclase phenocrysts, and numerous concentrations of fine-grained chlorite, occur. The intergrowth is delicate and commonly feathery, and is cut by numerous fractures. Opaque iron mineral grains are sparsely distributed throughout. The phenocrysts measure up to 1 mm. diameter.

DR49. Quartz-feldspar porphyry or dacite:

Most phenocrysts are plagioclase; a few are quartz and opaque iron mineral. Some of the opaque iron mineral, however, is partly converted to sphene. The groundmass is extremely fine-grained and consists mainly of alkali-feldspar and quartz. Accessory minerals are apatite, zircon, and chlorite; finely divided opaque iron mineral dusts the thin section in places. Most phenocrysts measure from 0.5 to 2 mm.

DR65. Adamellite:

It contains microcline, quartz, sodic plagioclase, muscovite, apatite, and opaque iron mineral. The mineral grains are partially granulated, and those of plagioclase are sericitized and turbid; undulose extinction is common. The muscovite flakes are well-cleaved and flexed. Grainsize is variable; most grains measure from 0.5 to 4 mm. across.

DR66. Sericitized quartz-albite porphyry:

Most phenocrysts are microcline; a few are quartz and albite. These are set in a groundmass of quartz, sericite, accessory biotite, and rare apatite. The rock has been partially granulated. Opaque iron mineral grains are widespread. Phenocrysts measure up to 1 mm. across, and quartz grains in the groundmass average 0.1 mm. in diameter.

DR106. Granodiorite porphyry:

It contains phenocrysts and glomeroporphyritic patches of plagioclase in a crystalline groundmass that is partly granophyric. The plagioclase is oligoclase. Most of the groundmass is quartz and alkali-feldspar; small amounts of chlorite, opaque iron mineral, and leucoxene, as well as accessory apatite, are present. Partial granulation is indicated by fractured grains with undulose extinctions by numerous cracks outlined by iron staining and mica concentrations. Most phenocrysts measure from 0.5 to 4 mm. in diameter.

DR.109. Porphyritic and amygdaloidal acid lava:

The thin section contains idiomorphic phenocrysts of oligoclase, and amygdules of quartz and fine mica, in a finely

granophyric base. A few aggregates of strained quartz grains have opaque iron mineral bordering the grains. Some of the base is replaced by silica. Small spherules (0.2 mm. diameter) occur throughout; many are coloured red-brown. Muscovite flakes fleck, and small opaque iron mineral grains dust, the thin section. Finely divided hematite causes rusty-brown colouration in places. Most phenocrysts measure from 1 to 2 mm., and the amygdules mostly range from 0.5 to 1 mm. in diameter.

DR110. Quartz-feldspar porphyry or metadacite:

Most phenocrysts are of altered oligoclase, but some are corroded quartz. The groundmass is feldspathic and siliceous (partly silicifed in that silica and sericite possibly replace some original feldspar); some granophyric patches are present. Chlorite and biotite are concentrated into patches which are numerous and evenly distributed. Many of the silicified patches appear to be spherules of quartz. Opaque iron mineral is scattered throughout. Accessory minerals and apatite and sphene. Phenocrysts measure up to 3 mm., but many were about 1 mm. across. Alteration is low grade regional.

DR123. The Rock is probably best called a rhyolite:

However, the composition of the feldspar phenocrysts cannot be determined because of sericitization. The other phenocrysts are quartz. The groundmass is extremely fine-grained and consists of quartz, alkali, feldspar, and sericite. Small grains of opaque iron mineral occur throughout. Zircon is accessory. Phenocrysts measure up to 1 mm. across.

DR125. Dacite:

Phenocrysts are plagioclase and corroded quartz; criss-cross patches of biotite probably replace original ferromagnesian minerals. Most phenocrysts are oligoclase. Minor mineral constituents are calcite, chlorite, sericite, apatite, zircon, sphene, and opaque iron mineral. The groundmass is very fine-grained, crystalline, and fairly siliceous; it contains, quartz, alkali-feldspar and numerous small sericite flakes. A poor flow-structure is discernible, especially around the many idiomorphic plagioclase phenocrysts. Phenocrysts measure up to 3 mm. across. The rock has undergone low grade metamorphism.

DR129. Spherulitic granite porphyry:

Nearly all the phenocrysts are albite; the remainder are quartz, which are much smaller than those of plagioclase. The groundmass contains numerous spherules of orthoclase, subordinate quartz, and minor quantities of albite. Opaque iron mineral grains are fairly numerous, and iron-staining is not uncommon. Accessory minerals are leucoxene, chlorite, sphene, and apatite. Plagioclase phenocrysts measure up to 1 mm.; whereas the quartz phenocrysts are only about half this size.

DR139. Aplitic granite:

The thin section consists of xenomorphic microcline, quartz, and sodic plagioclase grains. The plagioclase is partly altered to sericite and clay, whereas the microcline is absolutely fresh. Both muscovite and biotite are present; some of the biotite is altered to chlorite accessory minerals

are zircon, apatite, sphene, and opaque iron minera. Secondary minerals are calcite, epidote, sericite, and chlorite. The texture is granular or saccharoidal: grain-size averages about 0.2mm, some grains measure up to 0.5 mm. in diameter.

DR141. Fine-grained basic igneous rock - probably metabasalt:

Most of it consists of small feathery needles of actinolite amphibole in a reconstituted feldspathic (andesine, about An_{40}) groundmass opaque iron mineral grains are evenly distributed throughout. Accessory minerals are chlorite, sphene, biotite, and apatite. The rock is fine-grained, and averages 0.2 mm. in diameter.

120NT/8
1st April, 1960.

Report No. 16

THE PETROGRAPHY OF SOME METAMORPHIC ROCKS COLLECTED IN THE BITTER SPRINGS AND RUBY GAP AREAS, NEAR ALICE SPRINGS, N.T.

by

W. R. Morgan

Introduction

Two suites of specimens were collected by Mr N. Jones, sometime Resident Geologist at Alice Springs, N.T., and were sent to the laboratory for petrological examination. Mr Jones wished to know if either of the rock suites showed any change in their grade of metamorphism. The petrographical descriptions are followed by some comments on the metamorphism.

Mr Jones gave the localities of the specimens as follows :

(a) Bitter Springs area, referring to plate 8 of Bulletin 26 (Joklik), approximately 1 mile north of the Arltunga Road, with specimen 1 just within the boundary of the Bitter Springs, No. 2 about a ½ mile to the east (in the Arunta), and specimens 3 and 4 are respectively ¾ and 1 mile east of number 1.

(b) Ruby Gap area, again referring to plate 8 of Bulletin 26: specimen 1, ¼ mile north of the north end of Ruby Gap; specimens 2a, 2b and 2c are from approximately 1½ miles N.W. of the north end of Ruby Gap. Specimen 3 - 2 miles west of Ruby Gap, and specimen 4 collected from 3 miles north of Ruby Gap.

PETROGRAPHY

A. Specimens from the Bitter Springs Area

Specimen 1. Slide number 4257

The hand specimen is a fine- to medium-grained pale bluish-grey rock in which irregular and cracked patches of grey calcite-poor material are enclosed by bluish calcite-rich rock. On the weathered surface the two rock-types appear to form a rough, coarse banding: a pattern of cracks running through the quartz-rich material lies obliquely to this banding.

In thin section, the calcite-rich areas are seen to be composed of calcite, actinolite, epidote and quartz, with rare sphene, pyrites, black iron ore, and leucoxene. Calcite forms a roughly equigranular mosaic of grains that have an average size of 0.2 mm. in diameter. Actinolite occurs as subidioblastic, pale green to colourless crystals that poikiloblastically enclose quartz and epidote. Very pale yellow epidote forms roughly tabular-shaped crystals that are often associated, and sometimes intergrown, with actinolite. Quartz is more rare, and occurs as subrounded grains having slightly sutured margins. Small amounts of

sphene are present as rather rounded prismatic crystals that are pleochroic from pale to medium brown. A few small grains of pyrites and black iron ore may be seen, and leucoxene is associated with actinolite.

The calcite-poor patches are fine-grained, and the constituent minerals of each show some lineation although the direction of lineation differs from patch to patch. Quartz forms a mosaic of xenoblastic crystals whose average grain-size is 0.02 mm. in diameter. Actinolite occurs as fine, lineated prismatic crystals, and also, sometimes, as larger, poikiloblastic crystals on the edges of the calcite-poor patches. Epidote is granular, and some pale green, interstitial chlorite is present.

Coarse-grained, irregular veins of calcite, sometimes containing actinolite and epidote, cut the rock, and appear to be concentrated in the zone of calcite - poor patches.

A visual estimate of the percentages of minerals present in the calcite-rich area is :- calcite: 40, epidote: 30, actinolite: 20, quartz: 5, other minerals: 5. In the calcite - poor patches, the estimated percentages are:- quartz: 30, actinolite: 25, epidote: 30, chlorite: 15, in some of these areas, calcite is present, and may have been introduced.

The calcite-rich area is a quartz-actinolite-epidote-calcite granulite, and the fine-grained areas appear to be chlorite-actinolite-epidote-quartz schist.

Specimen 2. Slide number 4257

The hand specimen is a pale cream gneissic rock in which thin, discontinuous layers of greenish material composed of epidote and amphibole, with some pink feldspar, are enclosed by thicker layers consisting mostly of calcite.

In thin section, the thicker calcite-rich layers consist mostly of calcite, with smaller amounts of amphibole, epidote, microcline, quartz and sphene. Calcite forms an inequigranular mosaic of xenomorphic grains, ranging between 0.08mm. and 0.4 mm. in size, many of which show multiple twinning. Amphibole occurs as subidioblastic prismatic crystals which are zoned from green actinolitic hornblende in their cores to colourless tremolite on their margins. Pale yellow epidote is granular. Minor amounts of microcline and quartz form xenomorphic grains. Sphene is accessory.

The thinner discontinuous layers are composed of epidote and amphibole, with smaller amounts of calcite. The epidote is tabular to granular, and the amphibole is prismatic, and is zoned as in the calcite-rich layer. Minor amounts of microcline and quartz are present.

A visual estimation of the percentages is:- calcite: 75, epidote: 15, amphibole: 8, quartz and microcline: 2. The rock is an amphibole-epidote-calcite gneiss.

Specimen 3. Slide number 4258.

On a fresh surface the hand specimen is dark grey, mottled with epidotic green. The rock is fine- to medium-grained, and a faint foliation is discernable, the individual folia being 1 mm. to 4 mm. thick. The rock is cut by thin veins of calcite.

In thin section the specimen's texture is medium-grained, foliated, and granular-nematoblastic. The rock is foliated into quartz-rich, and epidote and hornblende-rich layers. Quartz and microcline form a mosaic of xenoblastic grains ranging in size between 0.03 mm. and 0.15 mm.; in one place a layer of quartz occurs in which the grains form an interlocking mass of large crystals, their grain-sizes ranging between 0.6 mm. and 1.5 mm. in diameter. Epidote is pleochroic in pale yellow, and occurs as roughly tabular grains that are commonly intergrown with green hornblende. Hornblende is xenoblastic and poikiloblastic in the quartz-poor layers, and forms roughly prismatic crystals, elongated parallel to the foliation in the quartz-rich layers. Hornblende is pleochroic with X = pale yellow green, Y = olive green, Z = turquoise green. Rarely, the mineral is fringed by colourless tremolite. Masses of fine-grained, randomly oriented sericite may sometimes be seen in quartz-poor layers; it may possibly replace felspar. Some granular calcite is present in a few of the quartz-poor layers; thin veins of calcite also cut the rock. Accessory octahedra of black iron ore, granular sphene, and prismatic zircon and greyish tourmaline are present.

A visual estimation of the percentages of minerals present in this specimen is :- quartz: 30, microcline: 20, epidote: 20, hornblende: 15, sericite: 7, calcite: 5, and accessory minerals: 3. The rock is a hornblende-epidote-microcline-quartz gneiss.

Specimen 4. Slide Number 4259

The hand specimen is a porphyroblastic, silvery-grey schist showing a false cleavage.

Thin section shows that the rock is medium-grained, porphyroblastic, and lepidoblastic-granular, the schistocity showing numerous plications due to the false cleavage. In the groundmass, the grain sizes range between 0.1 mm. and 0.4 mm. in diameter, and the porphyroblasts measure up to 3.5 mm. in size.

In the groundmass, quartz forms angular grains elongated parallel to the schistocity. Biotite and muscovite occur as oriented flakes. The biotite is a dark, dusty brown, and is commonly altered to pale green chlorite.

The groundmass schistocity is wrapped around the porphyroblasts. The larger porphyroblasts have an irregular shape, and consist of innumerable wavy and intertwined acicular crystals of sericite, apparently pseudomorphing sillimanite. Smaller porphyroblasts, consisting of muscovite, have an idioblastic, rectangular shape, and may pseudomorph kyanite.

Black iron ore forms tabular crystals. Accessory apatite and tourmaline are present.

A visual estimate of the percentages of minerals present is:- Muscovite: 40, biotite: 20, quartz: 25, chlorite: 10, other minerals: 5. The rock is a porphyroblastic chlorite-biotite-quartz-muscovite schist.

B. Specimens from the Ruby Gap Area

Specimen 1. Slide Number 4250.

The mineral causing the spots in this specimen is hydrated iron oxide. The mineral partly or wholly fills

square to rectangular-shaped cavities that are commonly surrounded by quartz showing pressure shadows. It seems likely that the hydrated iron oxide is pseudomorphing pyrites.

Specimen 2a. Slide number 4251

The hand specimen is a pale greyish-blue foliated rock, containing thin layers and lenticles of quartzo-feldspathic material enclosed by darker and somewhat thicker layers of more micaceous rock.

In thin section, the rock is seen to be porphyroblastic and porphyroclastic, the larger grains being enclosed in alternating quartzo-feldspathic and micaceous folia. The micaceous folia are wrapped around the porphyroblasts and porphyroclasts.

The porphyroclasts, which range up to 3.0 mm. in size, are formed of quartz and albite. Both minerals are commonly microfractured and partly granulated, and are sometimes auger-shaped. Much of the finer-grained xenoblastic and granular material in the quartzo-feldspathic folia appear to result from the breakdown of the porphyroblasts.

The micaceous folia consist mostly of fine flakes of muscovite, with some granular epidote and quartz, and small amounts of pale brown biotite.

The porphyroblasts are composed of sub-tabular crystals, and clusters of crystals, of epidote that is pleochroic in pale yellow. In places, it has quartz and albite intergrown with it. One porphyroblast has a thin vein of epidote enclosing an exceedingly fine-grained mass of crystals of a mineral with very low birefringence, and negative refringence. It is possible that this porphyroblast is altered allanite.

Hydrated iron oxide stains some of the muscovite. Accessory apatite and sphene are present.

A visual estimate of the percentages of minerals that are present is :- quartz: 35, muscovite: 30, albite: 25, epidote: 9, other minerals: 1. The rock is an epidote-albite-muscovite-quartz schist.

Specimen 2b. Slide Number 4252

The hand specimen is a fine-grained metamorphic rock that is finely foliated into quartzo-felspathic and micaceous layers.

In thin section the quartzo-feldspathic layers are seen to be inequigranular, the grain-sizes ranging between 0.015mm. and 0.24 mm. in diameter. They are composed of xenoblastic grains of quartz and albite, with more rare granoblastic epidote. The micaceous bands are equally fine-grained, and are composed of xenoblastic, lineated flakes of mica, granular epidote, and rare greenish-brown flakes of biotite.

Rare porphyroblasts of yellowish epidote are present; some have a core consisting of very fine crystals of a pale green mineral which may have replaced allanite, relict crystals of which are seen to be associated with this mineral in one or two places.

Some hydrated iron oxide is present in the Mica bands. Rare "cubes" of hydrated iron oxide are present and probably pseudomorph pyrites.

A visual estimation of the percentages of minerals present is:- quartz: 40, albite: 30, epidote: 10, muscovite: 15, other minerals: 5.

The rock is an epidote-muscovite-albite-quartz schist.

Specimen 2c. Slide Number 4253.

The hand specimen is a dark greenish-grey, fine-grained and thinly laminated metamorphic rock. The laminae tend to be lenticular, and is wrapped around small augen of felspar.

In thin section the rock is seen to be fine- to medium-grained, the average grain-size being 0.03mm. In texture it is granoblastic-lepidoblastic, and is sparsely porphyroblastic, the rare porphyroblasts attaining a size of 0.2mm.

In the groundmass, quartz and feldspar form a mosaic of xenomorphic grains that have crenulate margins. Pale yellow epidote is granular, and occurs in laminae and strings of grains. Small, pale brown flakes of biotite are xenoblastic and lineated. Sphene forms tabular to wedge-shaped crystals, and apatite occurs as minute acicular euhedra enclosed in albite, or as larger tabular grains ranging up to 0.2 mm. in size. Small amounts of sericite flakes are present. Hydrated iron oxide forms octahedral crystals pseudomorphing pyrite, and is also present as dust staining mica.

The rare porphyroblasts are formed of roughly tabular crystals of epidote, and of augen shaped grains of albite.

A visual estimate of the percentages of minerals present is:- quartz: 30, biotite: 25, epidote: 35, albite: 15, sphene, apatite and hydrated iron oxide: 5. The rock is an albite-epidote-biotite-quartz schist.

Specimen 3. Slide Number 4254

The hand specimen is a pinkish-cream, medium- to coarse-grained, apparently granitic rock that contains pink and white feldspar, quartz, thin, flattened and lineated patches composed of mica and epidote.

In thin section the rock is seen to be medium- to coarse-grained and porphyroblastic; the grain sizes range from 0.06 mm. to 3.6 mm. in diameter. The rock consists of an equigranular mosaic of quartz, slightly sericitized albite and faintly kaolinized microcline grains showing a shear fabric that is wrapped around xenoblastic augen of microcline-perthite and albite. Granules and strings of granules of pale yellow epidote associated with small flakes of sericite may be seen. Small amounts of granular leucoxene are present. Octahedral grains of hydrated iron oxide probably pseudomorph pyrites.

Much of the groundmass feldspar shows only slightly twinning, hence, it is difficult to estimate the percentages of microcline and albite present; however, they appear to be present in roughly equal amounts. There is about 25-30% of quartz, and epidote, muscovite and leucoxene form about 5% of the specimen. The rock is a sheared adamellite.

Specimen 4. Slide Number 4255

The hand specimen is a dark green schist composed of lineated mica and chlorite enclosing lenticles of fine quartzo-feldspathic material.

In thin section muscovite and green to fawn chlorite occur separately in felted layers, their flakes having an average length of 0.3 mm. Sparse grains of quartz and albite occur in the felted layers, but they are mostly concentrated into the lenticles, where they form fine- to medium-grained mosaics of xenoblastic grains: some irregular grains of chlorite and mica, and small amounts of calcite, are present in the quartzo-feldspathic lenticles. Some accessory zircon causes pleochroic haloes in chlorite. Cubic crystals of hydrated iron oxide probably pseudomorph pyrites.

A visual estimate of the amounts of minerals present is:- quartz: 30, muscovite: 40, chlorite: 20, and albite: 10. The rock is an albite-chlorite-quartz-muscovite schist.

COMMENTS

(a) Specimens from the Bitter Springs Area

Specimens 1, 2 and 3 are of the greenschist facies of regional metamorphism (Turner, Fyfe, and Verhoogen, 1958). However, some rise in the grade of metamorphism from specimen 1 to specimen 3 is shown by the amphiboles. In specimen 1 the amphibole is almost colourless, in specimen 2 it is green, zoned to a colourless margin, and in specimen 3, the green amphibole rarely has a colourless margin, and is probably hornblende. Increase in intensity of colouration has been used by others to show rise in grade of metamorphism, notably in a study of metamorphosed rocks in the Gosaisyo - Takanuki District, Japan, by A. Miyashiro (1958) who uses the colouration of amphibole to zone his rocks.

However, it should be noted that in specimen 2, and rarely in specimen 3, the green amphibole is bordered by tremolite, I.E., the higher grade mineral is enclosed by the lower grade mineral. If zonation of a mineral is present in a progressively metamorphosed rock, I would expect the higher grade mineral to enclose the lower grade. Hence, it seems likely that specimens 1 and 2 have suffered retrogressive metamorphism when compared with specimen 3.

Specimen 4 is now of the greenschist facies, although the pseudomorphs of sericite after sillimanite and kyanite show that it has been retrogressively metamorphosed from a much higher grade. The original grade of metamorphism of this rock I think to be higher than that of specimen 3, judging from the appearance of the latter rock.

(b) Specimens from the Ruby Gap Area

No change of grade of metamorphism was detected between specimens 2a, 2b, and 2c. Lambert (1958), in detecting a metamorphic boundary in the Moine Schists, Scotland, used a method whereby he measured the anorthite content of plagioclase, and obtained some idea of the iron content of epidote by measuring its birefringence, the idea being that the anorthite content of the plagioclase, and the iron content of the epidote should increase with a rise in grade of metamorphism. This method was used here, with the following results :

Specimen Number	Plagioclase composition	Epidote birefringence
2a	An_7	0.065
2b	An_8	0.070
2c	An_{10}	0.060

It will be seen that within the limits of error of the method of determination, neither the plagioclase nor the epidote have any significant change in composition. The specimens are all of the same grade of metamorphism, and belong to the quartz-albite-epidote-biotite subfacies (Fyfe, Turner and Verhoogen, 1958).

Specimen 4 is a greenschist of a slightly lower grade than that of specimens 2a, 2b, and 2c, i.e., it is of the quartz-albite-muscovite-chlorite subfacies.

REFERENCES

FYFE, W.S., TURNER, F.J., and VERHOOGEN, J., 1958: Metamorphic reactions and Metamorphic facies. Geol. Soc. Am. Mem. 73.

LAMBERT, R. ST. J., 1958: A metamorphic boundary in the Moine Schists of the Morar and Knoydart districts of Inverness-shire. Geol. Mag., Vol. XCV, No. 3, p. 177.

MIYASHIRO, A., 1958: Regional metamorphism of the Gosaisyo-Takanaki district, Central Abukuma Plateau. Jour. Fac. Sci. Univ. Tokyo, Ser. II, Vol. XI, Pt 2, p. 219.

WINCHELL, A.N., and WINCHELL, H., 1951: Elements of Optical Mineralogy, Vol. II. Descriptions of Minerals. John Wiley & Sons, Inc., New York.

50 PNG/1
13th April, 1960.

Report No. 17

THE PETROGRAPHY OF FIVE SPECIMENS FROM THE LALOKI MINE, PORT MORESBY, T.P.N.G.

by

W. R. Morgan

Introduction

The five specimens were obtained by J.E. Thompson and H.L. Davies from D.D.H. M83 SC2, Laloki Mine, Port Moresby. The specimen numbers and their depths in the hole are listed as follows :

P.421 - 170 feet
P.422 - 347 feet
P.423 - 436 feet, 9 inches
P.424 - 439 feet, 9 inches
P.425 - 455 feet.

The reason for this report is to decide whether or not the basic igeous rock represented by specimens P.424 and P.425 is intruded into the sedimentary rocks represented by P.421, P.422, and P.423.

Petrography

P.421, slide number 5390

The hand specimen is a fine- to medium-grained, greyish-buff apparent sandstone. On one of the specimen's surfaces a thin layer of more coarse grit containing sub-angular to sub-rounded grains is present.

The thin section presents rather serious difficulties in mineral identification. The rock appears to consist mostly of angular to sub-angular, sometimes shard-shaped grains of brown to black (?)basaltic (?)glass. Some grains contain this (?)glass in laminated intergrowth with a mineral that is pleochroic from almost colourless to purplish-blue ((?soda-amphibole). Quite commonly, the (?) glass has a rim of a reddish-brown, anisotropic and sometimes fibrous mineral. Rounded grains composed of masses of minute flakes of green nontronite are present. Some grains of two other unidentified minerals were noted: one is a reddish-brown anisotropic mineral with fairly high relief; the other is a greenish-brown isotropic mineral with high relief. Grains composed of fine-grained shale were observed. Rare grains of plagioclase, quartz, green hornblende, carbonate, and apatite are present.

The grains are cemented by (?)zeophyllite, which makes up about 50% of the rock. It is a colourless mineral which forms partly coalesced, sub-radial fibres, and has a low to moderate birefringence, a refractive index of 1.56-1.57, and is uniaxial negative. Small amounts of sericite are intergrown with the (?)zeophyllite. Commonly, a thin rim of a colourless anisotropic mineral with a negative refringence, surrounds the grains of basaltic (?)glass: this mineral may be fluorite or opal.

P.422, slide number 5391

In hand specimen the rock is a dull, dark purplish-brown breccia containing coarse sub-angular and angular fragments that range up to 1.5 cm. in size. The fragments and matrix are composed of fine-grained material that reacts with dilute HC1, showing that calcite is present. Irregular veins of calcite cut the rock.

In thin section, coarse angular to sub-angular fragments are seen to be enclosed in a fine-grained matrix. The matrix grains range between 0.004 mm. and 0.024 mm. in size, and consist of fairly abundant calcite, very minor amounts of quartz, more rare grains of pale green chlorite, and very rare grains of plagioclase; all these grains are enclosed in extremely fine-grained hydrated iron oxide dust. In places, the iron oxide dust becomes so thick that it has the appearance of forming irregular veins cutting the matrix.

Many of the fragments are commonly formed of calcilutite and slightly silty calcilutite. Some fragments contain hydrated iron oxide dust; in others, this dust is absent. Rarer small fragments are composed of aggregates of fine flakes of pale green, nearly isotropic chlorite whose refractive index is only slightly above that of quartz.

Thick irregular veins cutting the rock contain coarse granular calcite and rare lamellar barytes.

The rock is a veined ferruginous calcilutite breccia.

P.423, slide number 5392

Like sample P.422, the hand specimen is a breccia. The main differences are that it is light grey, and that the matrix and fragments are only slightly softer than steel. Application of dilute HC1 shows that calcite is present in both the matrix and the fragments. Calcite veins are present, but they are thinner and less common than in P.422.

In the thin section the texture is seen to be similar to that of P.422. Most of the fragments are composed of calcilutite and silty calcilutite: others are composed of aggregates of fine-grained flakes of very pale green chlorite. The calcilutite fragments contain granules of apparent leucoxene, and rare small cavities occupied by fine flakes of chlorite.

The matrix is formed of fine-grained granular calcite, (?)leucoxene, and quartz, and of fine, anhedral chlorite flakes.

Thin veins cut the rock, and are composed of calcite and zeolite, the minerals occurring singly in some, and together, with yellow epidote, in others. Small aggregates of irregular grains of pyrites and zeolite are clustered in places in the rock. These aggregates are not confined to the fragments, but also occur in the matrix.

The zeolite in both the veins and the aggregates forms fine-grained intergrowths of sub-tabular crystals that have oblique extinction: it is possibly laumontite.

The rock is a veined calcilutite breccia.

P.424, slide number 5393

The hand specimen is of a dark grey, fine- to medium-grained basic igneous rock.

In thin section, the rock is seen to consist almost entirely of zeolites and actinolitic hornblende, with small amounts of black iron ore. Its texture, viewed in ordinary light, gives the impression of being doleritic. The intersecting sub-tabular laths of feldspar are represented by zeolite, and are sub-ophitically intergrown with anhedral to subhedral crystals of green actinolitic hornblende that probably pseudomorphs pyroxene. Black iron ore forms anhedral grains that are commonly associated with actinolitic hornblende.

The specimen is cut by one or two irregular zones of crushed rock composed of sub-angular grains of zeolite and actinolitic hornblende embedded in a fine-grained matrix of these minerals. Several veins of zeolite also cut the rock.

The main zeolite replacing feldspar appears to be analcite, although some (?)thompsonite and (?)laumontite are also present. Veins composed of analcite are cut by later veins containing (?) thompsonite and (?)laumontite.

A visual estimation of the percentages of minerals present is :- zeolites: 50, actinolitic hornblende: 45, black iron ore: 5. The rock is a zeolitized and uralitized dolerite.

P.425, slide number 5394

The hand specimen is a dark grey, fine- to medium-grained basic igneous rock that is cut by several thin irregular veins of zeolite.

In thin section, the rock is seen to be composed of zeolites, actinolite, oligoclase, augite and black iron ore. The rock's texture is fine- to medium-grained and doleritic. Much of the feldspar is replaced by analcite and (?)thompsonite. In places, (?)thompsonite forms masses of small, radially fibrous crystals which almost obliterate the pre-existing texture. Commonly, the zeolites are clouded by alteration products. The laths of feldspar are sub-ophitically enclosed by sub-prismatic, colourless augite, much of which is now replaced by pale green, fibro-prismatic actinolite. Irregular grains of black iron ore are often associated with actinolite.

Some veins of fibrous (?)thompsonite cut the rock. One of these is seen to be cut by a fault along which a thin crushed zone is present.

The rock is a partly zeolitized and uralitized oligoclase dolerite.

Comments

Specimens P.424 and P.425 are uralitized and zeolitized dolerites; no chilling effects were observed in P.424. Specimens P.422 and P.423 are calcareous breccias. The main difference between the two specimens is the presence of hydrated iron oxide dust in P.422, and its absence in P.423. No hornfelsing of P.423 was noted. Both specimens are cut by veins. In P.422 the veins contain calcite and small amounts of barytes. The veins in P.423 contain zeolite, calcite, and epidote: this specimen, on Mr Thompson's evidence, occurs

very close to the contact with the dolerite. Bearing in mind that the dolerite is extensively zeolitized, it seems likely that the zeolite and epidote in the veins are derived from the dolerite. From this, it is probable that the dolerite intrudes the breccia.

As mentioned before, specimen P.421 presents serious difficulties in mineral identification; the description I have given is the result of long and arduous discussion between Mr Dallwitz and myself. At the moment we would call the rock a tuff or resorted tuff, but we are by no means sure. We would like some more of this material, in order to carry out more detailed mineralogical and chemical work ourselves. Later, we are considering sending some of the material to Professor C.E. Tilley, and to Howel Williams, of the University of California, who is an expert on volcanic rocks. Mr Dallwitz is also of the opinion that Australian Universities would be interested in obtaining some of this material.

206PNG/8
5th May, 1960.

Report No. 18

REPORT ON TWO SPECIMENS OF NEW LAVA FROM MANUM VOLCANO THE ERUPTION COMMENCING ON 17TH MARCH, 1960

by

C. M. Gregory

Descriptions of specimens M60/1 and M60/2, thin section numbers 5446 and 5447

In handspecimen the rocks are medium grained, dark grey, and with phenocrysts of pyroxene and olivine up to 2 m.m. across set in a very fine-grained matrix containing inconspicuous porphyritic crystals of plagioclase. Specimen M60/1 has low porosity; specimen M60/2 has a porosity of about 20% individual vesicles measuring from 2 mm. in diameter downwards.

Thin sections show the texture to be intersertal with large grains of pyroxene and olivine ranging up to 2 m.m. diameter and plagioclase crystals ranging in diameter from 2 m.m. down (average 0.25 m.m.), set in a dark microcrystalline groundmass of plagioclase, yellowish pyroxene and black magnetite. Plagioclase grains measuring up to 2 m.m. in diameter are rare; most measure 1 m.m. or less.

The olivine is colourless with a tendency to euhedral crystals but most of these have been partially resorbed and have corroded and embayed edges. Crystals are generally quite cracked but replacement along cracks has not occurred. In some cases olivine is either partly or completely surrounded by pyroxene and here it is not readily apparent that the pyroxene is a reaction product of the olivine although this is the most probable situation.

The pyroxene is a slighly pleochroic, (from a very pale yellow-green to a pale greenish-yellow) clinopyroxene, probably augite. The larger grains are commonly euhedral and zoned and may show twinning. Cleavage planes are well developed, and grains may be crowded with inclusions of plagioclase and/or iron oxide. The smaller grains have very ragged serrated edges which makes them appear to grade into the matrix. The very fine grains in the matrix are intermixed with the other minerals into a mass that defies clear resolution. Some hypersthene occurs as rather rare inclusions in the clinopyroxene; its pleochroism is very much stronger than in the clinopyroxene.

Plagioclase crystals have developed as laths and as microcrystalline anhedra in the groundmass. The laths are very finely zoned with normal and oscillatory zoning. Carlsbad, albite and pericline twin types are all common. From Carlsbad/albite twins the composition of the plagioclase was calculated to range between An80-90 bytownite. Grains are very commonly crowded with inclusions of glass in well-defined zones parallel to the grain outlines. Magnetite has developed as randomly placed inclusions. Many of the larger crystals of plagioclase show rounded outlines due to magmatic corrosion.

An estimate of composition of the rock is 20% plagioclase phenocrysts, 15% pyroxene phenocrysts, 5% olivine phenocrysts and 60% groundmass.

The rock is a porphyritic olivine - bytownite basalt.

Remarks:

In comparing petrographically these two specimens of the most recent basalts from Manum volcano with the samples from the 1957-58 eruption, it is found that they are very similar. However, since the latter samples are more numerous an accurate comparison is not possible. Some of the older rocks are slightly different from the younger ones but others among them are indistinguishable. Where there is variation it is in the porosity and/or colour index of the matrix due to a greater amount of plagioclase in the older rocks. The plagioclases are the same type, olivine is present in both the 1957-58 and 1960 lavas, and the same clinopyroxenes are present. Hypersthene is a rare constituent of one of the 1960 lavas (slide 5446, specimen M60/2).

More samples are needed for an accurate comparison.

106G/13/37
16th May, 1960.

Report No. 19.

Petrographic Examination of Two Core Specimens From South of Beaudesert, Queensland

by

W. B. Dallwitz

Following is a report on two specimens selected from core 10, Queensland American Oil Company's Overflow No. 1 bore, situated south of Beaudesert, Flinders 1-mile sheet, Ipswich 4-mile sheet, Queensland.

Core 10, 1639'-1639'5"

A grey, hard, fine-grained rock showing what appears to be a rather indistinct, discontinuous, irregular "banding" at right angles to the length of the core. In one place the core has broken along a crack lying almost at right angles to the banding, and a thin encrustation of pale pinkish buff feldspar is adhering to a small part of the broken surface. The "banding" noted above is expressed as sub-parallel, slightly paler grey lenses and anastomosing streaks which are from 0.25 to 1 mm wide, and which generally lie from 2 to 5 mm. apart.

In thin section (slide 5450) the rock is seen to consist of plagioclase microlites (60%), augite granules (20%), potash feldspar (10%±), and accessory quartz, chalcedony, magnetite, hematite, chlorite, leucoxene, and calcite. Small porphyritic feldspar crystals are rare.

Within the lenses and anastomosing streaks noted in handspecimen the feldspar microlites show a sub-parallel arrangement. The microlites lying between these structures have a sub-parallel to random arrangement; where they are sub-parallel they may make an angle of up to 90° with the microlites in the streaks and lenses, and they may be in the plane of the section, at right angles to it, or anywhere between these extremes. The explanation of these features can only be guessed at, but it is most probable that they are attributable to flow.

The feldspars in the rock are labradorite (An_{55}) and potash-feldspar whose exact identity could not be determined. The size of the labradorite microclites is variable, but averages about 0.12 mm. X 0.015 mm. The potash feldspar occurs interstitially to the plagioclase microlites, and as irregular patchy intergrowths with some of the microlites; its percentage is very difficult to estimate.

Augite occurs as equidimensional and stumpy prismatic grains whose average size is 0.015 to 0.03 mm. in diameter. Some grains are larger, and a few measure up to 0.08 mm. in diameter.

Quartz and chalcedony are more plentiful in some of the narrow lenses and streaks than in the material lying between them. Magnetite occurs as octahedra measuring from 0.015 to 0.05 mm. in diameter, and hematite forms irregular, generally elongated clots partly replacing the rock; these clots, as seen in the slide, measure up to 2 mm. in diameter

but some more than twice as long are present in the hand-specimen.

Chlorite appears in two forms - as books probably replacing biotite and as extremely fine-grained material associated with calcite and chalcedony in rare amygdales.

It is not easy to name this rock satisfactorily. The choice seems to be between trachyandesite and trachybasalt, although the rock differs from each of these as typically developed.

Williams, Turner, and Gilbert "Petrography", Freeman, 1955, p.57) state that trachybasalts "are characterised by the presence of olivine and augite, by plagioclase more calcic than andesine, and by potash feldspar -- amounting to more than 10 percent. The plagioclase, which may be as calcic as anorthite, generally forms phenocrysts --". The rock described here contains no olivine, and the plagioclase only rarely forms phenocrysts.

Of trachyandesites, Williams, Turner and Gilbert say (p.97):

"These are the fine-grained equivalents of monzonites, though it is customary to include among them rocks with a lower ratio of alkali feldspar to total feldspar than that characteristic of monzonites, -- we extend the term "trachyandesite" to embrace all andesites with more than 10 percent modal or normative potash feldspar. -- The dominant plagioclase is andesine or oligoclase, but some phenocrysts, at least in their cores, may be as calcic as labradorite or even, occasionally, as bytownite. -- The usual pyroxene is pale-green diopsidic augite -- Most specimens contain phenocrysts of olivine . . .".

To summarise: the specimen described differs from trachyandesite and trachybasalt as characterised above in

(1) having only very rare porphyritic crystals of plagioclase;

(2) having no porphyritic crystals of pyroxene; and

(3) in the absence of olivine (which need not be present in trachyandesite).

In spite of these discrepancies, the best name for the rock appears to be <u>trachyandesite</u>; the presence of accessory quartz suggests that the rock is intermediate rather than basic, and the rather low percentage (20%) of ferromagnesian mineral tends to confirm this suggestion.

<u>Core 10, 1641'2" - 1641'7"</u>

This specimen is generally similar to that just described. The thin bands and lenticular elongated streaks are more prominently developed, and are almost strictly parallel; however, there are fewer of them, and they make an angle of about 25° with the length of the core.* A few veinlets up to 0.5 mm. wide are filled with calcite or red-brown material and chlorite.

* (contrast previously described rock wherein they are at right angles to the length of the core.)

In thin section (slide 5451) plagioclase laths aligned in directions more or less counter to those within the thin bands and lenses are extremely prominent.

The few porphyritic crystals of plagioclase altered to chlorite, and quartz with or without (?) acid plagioclase, sericite, and rare calcite. Calcite veins are absent, but veins consisting of the following minerals were noted:

(1) Iron-stained sanidine with minor amounts of hydrated iron oxide, chlorite, and calcite. The widest of these veins is about 0.2 mm. across, and the narrowest 0.05 - 0.025 mm. A peculiarity of these veins is that the feldspar may be in optical continuity for considerable distances (up to 2 mm. in the 0.2 mm. wide vein) along them.

(2) Iron-stained sanidine, iron oxide, and chlorite, grading along the length of the vein into iron-stained sanidine, and iron oxide.

(3) Chlorite, sanidine, iron oxide, calcite and quartz-grading into chlorite with rare chalcedony and clots of calcite.

Where veins of types 2 and 3 are relatively rich in chlorite, they show comb structure: crystals of sanidine protrude into a central layer of chlorite, and the two minerals are separated by a crust of iron oxide.

The rock is a trachyandesite.

Comments on likely age of the rocks

P.J. Stephenson (Geol. Mag. 96,(2), pp. 125-136, 1959), in dealing with the general geology of the area surrounding Mt. Barney, S.E. Queensland, mentions that marine Carboniferous rocks are unconformably overlain by freshwater Mesozoic sediments with some interstratified basic volcanics. The Mt. Barney Complex, described by Stephenson, is made up of diorites, dolerites, granophyres, trachytes, and basic to acid pyroclastic rocks, and is probably of Tertiary age.

N.C. Stevens, in his paper on the ring structures of the Mt Alford district, S.E. Queensland, (Journ. Geol. Soc. Aust., 6, (1), 1958) says that the country rocks into which the complex is emplaced belong to the Jurassic Walloon Coal Measures; he does not mention any associated igneous rocks in the area studied. The complex contains, among other things, plugs and sills of rhyolite and trachyte.

H.C. Richards (The Volcanic Rocks of South Eastern Queensland, Proc. Roy. Soc. Qld., 27, II, pp. 105-204, 1916) mentions a sill or flow of Tertiary trachyte in Walloon Coal Measures at Woodhill, 6 miles north of Beaudesert, and a plug of Tertiary trachyte at Cainbable Creek, 6 miles southeast of Beaudesert. Most of the Tertiary trachytes of the area are sodic, but the one at Cainbable Creek is not.

The above records of igneous activity show that the trachyandesite in the Overflow No. 1 bore could be either a Tertiary intrusive or a Mesozoic flow. As nearly all the Tertiary volcanic rocks in the area are sodic, and this one is not, a Mesozoic age seems the more likely. A specimen of the rock was shown to Professor D. Hill, of the University of Queensland, and to her its general appearance suggested a Mesozoic, rather than a Tertiary age.